(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 652 533 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **94117601.8**

(51) Int. Cl.[6]: **G06K 15/00**

(22) Date of filing: **08.11.94**

(30) Priority: **08.11.93 JP 278637/93**
08.11.93 JP 278638/93
08.11.93 JP 278639/93

(43) Date of publication of application:
10.05.95 Bulletin 95/19

(84) Designated Contracting States:
CH DE FR GB IT LI NL SE

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(54) Detection of the condition of a printer.

(57) A printing apparatus has, in addition to a normal command interpreter (66), a real-time command interpreter (64) for simultaneously analyzing control commands as data is received from a host device. This real-time command interpreter functions even when the printing apparatus is off-line, thereby enabling the status of the printing apparatus to be known even when the printing apparatus is not operating. Thus, the host device can be notified of the cause for non-operation thereby achieving a high throughput rate printing. The user can cancel a cut-sheet paper insertion wait-state at any time. Why an error occurred can be determined in an off-line state to enable recovery from the error.

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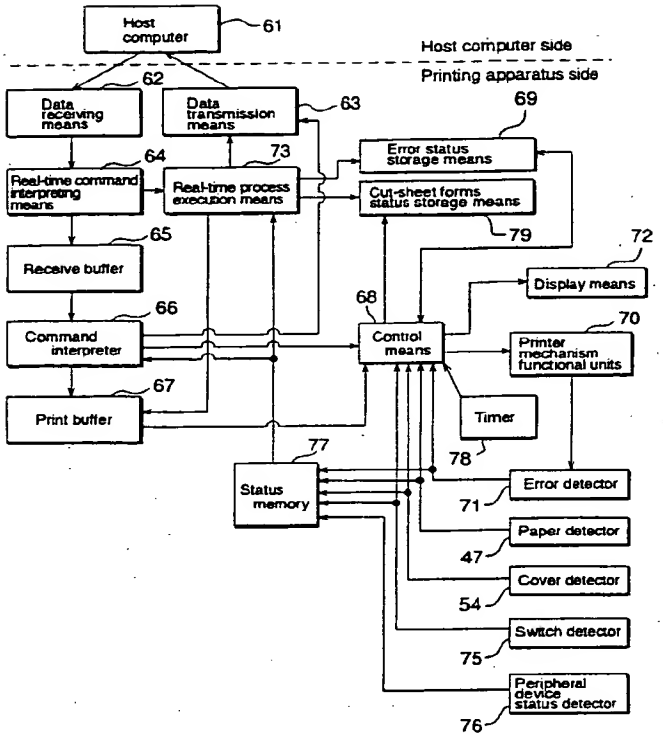

FIG. 5

The present invention relates to a printing apparatus for printing according to commands received from a host computer, and relates particularly to a printing apparatus suitable for data processing apparatuses, such as point-of-sale (POS) terminals and electronic cash registers (ECR), used in processing monetary transactions.

When it is inappropriate to continue a current printing operation, since, for instance, the paper supply is depleted, the printer cover has been opened, or an error has occurred, conventional printing apparatuses typically stop the printer mechanism containing the print head, and bring the interface to the host computer off-line (a logical non-connection state) to both protect the printing apparatus and the communications data, and assure user safety. Once this off-line state has been entered, however, internal control of the printer apparatus stops, and the data already transferred to the printer apparatus is no longer processed. Data is also no longer received by the printer apparatus, and the printer apparatus cannot receive or process any data output thereto or respond to inquiries from the host computer.

The printing apparatus even moves off-line when the form-feed switch is pressed and paper is being advanced, and when the data receive buffer storing the received data is full (a buffer full state), and it is difficult to distinguish between these off-line states and off-line states in which it is inappropriate to continue printing.

When the printing apparatus goes off-line, the host computer is no longer able to send the print data, and the complete system, POS, ECR, or other, comes to a stop. In such a case, the host computer typically displays a message such as "printer problem, please check" on a display device, and the user must manually inspect the printing apparatus and correct the problem leading to the off-line state. However, for many general POS and ECR users, determining the problem is often difficult and time-consuming.

On the other hand, control commands stored in the data receive buffer are interpreted in a first-in-first-out (FIFO, the first commands stored are the first interpreted) order, and the appropriate command process is executed. Control commands that have been processed are deleted from the data receive buffer. As a result, as control commands are successively input from the host computer, the commands are stored one after the other to the data receive buffer, and processed in order from the oldest control command stored. This creates a time lag between output of the control command from the host computer and actual execution of the control command by the printing apparatus.

In conventional printing apparatuses handling cut-sheet forms, the printer mechanism must be stopped to wait for insertion of the cut-sheet form when the host computer selects a cut-sheet form for printing. Because internal control of the printing apparatus stops at this time, the data received from the host computer once the cut-sheet form selection has been made is not processed, and there is no response from the printing apparatus, until the cut-sheet form is inserted or a predetermined cut-sheet form insertion waiting period is completed.

As a result, if the user mistakenly selects cut-sheet form printing, the POS/ECR terminal stops processing for such period, thus delaying further processing and causing the customer to wait. When the printing apparatus is reset or the power is turned off and then on again, the data controlling the printing apparatus settings stored in the printing apparatus is lost. This is a significant problem for a printing apparatus used in POS/ECR terminals in financial transaction systems.

Errors generated in the printing apparatus include recoverable errors, such as paper jams in the paper transport path, and non-recoverable errors, such as problems with the power supply voltage from the AC-DC converter and damage to the head temperature detector of the printing head. The methods of handling recoverable and non-recoverable errors differ greatly, and it is therefore necessary to distinguish between the two; this is, however, difficult for the average user.

Furthermore, even if the cause of the error is removed in conventional printing apparatuses, it is necessary to reset the printing apparatus or turn the power off and then on again to escape from the error state. Both of these operations also destroy the data stored to that point in the printing apparatus.

To minimize the effects of these problems, the host computer in data processing systems using such conventional printing apparatuses adds a status request command to each line of data instead of batch sending plural lines of data, and uses the response to determine the current status of the printing apparatus. This, however, adds significant overhead to the host computer, and leads to reduced throughput in the data processing system.

As a result of the above, stand-alone type dedicated data processing systems integrating the data entry device, processing device, and printing apparatus are widely used in conventional POS/ECR systems. Systems connecting a host computer with a printing apparatus using a general-purpose interface are not widely used, even though they offer excellent flexibility, due to data reliability problems (i.e., security issues). To improve data reliability and simultaneously improve operability (usability), it is desirable to have a data processing system whereby the cause of any stop in printing apparatus operation can be known

even while the printing apparatus is in a off-line state, and the cause of the problem can be quickly corrected.

Therefore, the object of the present invention is to provide a printing apparatus whereby the aforementioned problems of the prior art can be resolved; a high reliability data processing apparatus can be achieved; the overhead on the host computer can be reduced; and operation is user-friendly.

This object is achieved with a printing apparatus, a controlling method and a data processing apparatus as claimed in claims 1, 17 and 22, respectively.

Preferred embodiments of the invention are subject-matter of the dependent claims.

The embodiment of claim 14 enables the host device to recover from errors in the printing apparatus.

The embodiment of claim 16 further enables the host device to cancel a cut-sheet form insertion waiting state of the printing apparatus.

By means of the invention, it is possible for the host computer to determine and evaluate the cause of an off-line printing apparatus state even after the printing apparatus goes off-line. The host computer can thus notify the user by means of posting a message, and the system can recover from the off-line state by means of host computer control if the user corrects the cause of the problem. In addition, when the printing apparatus is in a cut-sheet insertion standby state, the waiting state can be cancelled by the user issuing a 'cancel cut-sheet insertion waiting state command' from the host computer.

According to a preferred embodiment, when an error occurs in the printing apparatus, it is also possible for the host computer to determine what error occurred and where, and whether the error is recoverable or non-recoverable. When the error is recoverable, it is also possible to recover from the error and resume printing once the user corrects the cause of the error. It is also possible to select whether to resume printing from the print line at which the error occurred, or to destroy all data already sent and then recover from the error.

Preferred embodiments of the invention are described below with reference to the accompanying figures, in which:

- Fig. 1 is an overview of a printing apparatus used to describe the preferred embodiment of the invention;
- Fig. 2 is a cross section illustrating the operation of the printing apparatus of the present invention;
- Fig. 3 is a a schematic view illustrating a printing unit of the printing apparatus according to a preferred embodiment of the invention;
- Fig. 4 is a block diagram showing an example of the control circuit for implementing a control method according to the present invention;
- Fig. 5 is a functional block diagram used to describe the preferred embodiment of the invention;
- Fig. 6 is an example of the command used in the preferred embodiment of the invention;
- Fig. 7 is a flow chart of a control method applied by the printing apparatus according to a preferred embodiment of the invention;
- Fig. 8 is a flow chart of a control method applied by the printing apparatus according to a preferred embodiment of the invention;
- Fig. 9 is a flow chart of a control method applied by the printing apparatus according to a preferred embodiment of the invention;
- Fig. 10 is a flow chart of a control method applied by the printing apparatus according to a preferred embodiment of the invention;
- Fig. 11 a conceptual diagram of the data processing apparatus of the invention;
- Fig. 12 is a flow chart of a control method applied by a host computer using a printing apparatus according to a preferred embodiment of the invention; and
- Fig. 13 is a flow chart of a control method applied by a host computer using a printing apparatus according to a preferred embodiment of the invention.

In general, recording paper used in the distribution industry is either cut-sheet or continuous forms paper. Cut-sheet paper includes irregularly sized, individual voucher forms called slip paper, and multiple-part individual voucher forms, called validation paper, of a relatively regular size. Continuous paper includes journal paper for printing and storing store records, and receipt paper used for simple receipts.

Fig. 1 is an overview of a printing apparatus capable of printing to slip-, journal-, and receipt-type recording paper.

As shown in Fig. 1, this printing apparatus comprises print head 1, which is typically a so-called "wire dot head" comprising plural wire pins arrayed in a vertical line; and ink ribbon 3. The print head 1 prints while being driven in a reciprocal motion as indicated by arrows 1A and 1B.

Receipt paper 17 and journal paper 18 are inserted from the back of the printer mechanism in roll form, and are fed out from the top as shown in the figure. Slip paper 19 is inserted from the front of the printer

mechanism (arrow 19A), and similarly fed out from the top (arrow 19B).

Near-end detector 20 for detecting the end of the receipt and journal paper is also provided. Near-end detector 20 comprises a near-end detecting lever 20a, which is arranged to be pushed out in the direction of arrow 20A by the end face of the roll paper as long as the outside diameter of the end face is larger than a certain minimum value, and a push switch 20b, which is turned on/off by near-end detecting lever 20a. The outside diameter steadily decreases as the end of the roll paper approaches, and when the core of the roll paper is reached, near-end detecting lever 20a rotates in the direction of arrow 20B. This causes push switch 20b to switch OFF, thus detecting the near-end of the paper.

After printing is completed, receipt paper 17 is cut by cutter unit 14, and can be handed to the customer.

The printer mechanism is covered by a housing not shown in the figures; this housing comprises a cover that is not shown and lower case 15. Cover detector 21 is an opposed-type photodetector, so called photo-interrupter. When the cover is closed, the beam from cover detector 21 is interrupted, and the cover is detected to be closed.

Fig. 2 is a cross section illustrating the operation of the printing apparatus of the present invention during printing to continuous and cut-sheet paper. Fig. 2 (a) shows printing to continuous paper (receipt paper in the figure); Fig. 2 (b) to cut-sheet paper (slip paper).

The wire pins (not shown in the figure) of print head 1 are provided in wire holder 1a for printing through ink ribbon 3 to receipt paper 17 against platen 2.

Receipt paper 17 is fed by transport rollers 6a and 6b past guide roller 5 and between paper guides 4a and 4b. The one transport roller 6a is connected to a motor or other drive power source (not shown in the figures).

Receipt paper detector 12 is a photo-interrupter, lever switch, or other detecting means positioned in the middle of paper guides 4a and 4b; receipt paper detector 12 is shown as a photo-interrupter in Fig. 2.

When transported by transport rollers 6a and 6b, receipt paper 17 passes between ink ribbon 3 and platen 2, through presser rollers 7a and 7b and cutter unit 14, and is fed out from the top of the printing apparatus. The cutter unit 14 comprises cutter blade 14a and cutter cover 14b; cutter blade 14a is driven in the direction of arrow 14A by a motor or other drive power source to cut receipt paper 17.

It is to be noted that while receipt paper is shown in the figure, the mechanism used for journal paper is the same except for the cutter unit. This is because journal paper is used for storing data by the store, and is not used for customer receipts.

When slip paper is printed (Fig. 2 (b)), slip paper 19 is inserted from slip paper insertion opening 22 at the front of the printing apparatus in the direction of arrow 19A. During roll paper printing, slip transport roller 9a is pulled in the direction of arrow 10A by plunger 10 as shown in Fig. 2 (a), and is thus separated from the opposing slip transport roller 9b. As a result, it is possible to insert slip paper 19. When slip paper 19 is inserted, slip paper 19 passes between slip paper guides 11a and 11b and abuts slip transport rollers 8a and 8b. Whether slip paper has been inserted is detected by slip paper detector 13. If paper has been inserted, plunger 10 is released and lever 10a moves in the direction of arrow 10B, thus pressing slip transport roller 9b against slip transport roller 9a, and holding slip paper 19 therebetween.

Slip transport rollers 8b and 9b are connected to a motor or other drive power source not shown in the figures, and slip paper 19 is transported as slip transport rollers 8b and 9b and the opposing slip transport rollers 8a and 9a rotate in the direction of arrows 8A, 9B, and 8B, 9B respectively. When printing is completed, slip paper 19 is fed out in the direction of arrow 19B, plunger 10 is driven to separate slip transport roller 9a from slip transport roller 9b, and the next slip paper form can be inserted.

Printing on slip paper 19 is possible with receipt paper 17 loaded as shown in the figure, and if carbon-copy paper is added to slip paper 19, the same information can be simultaneously printed to both slip paper 19 and receipt paper 17.

Note that slip paper detector 13 is a photo-interrupter similar to receipt paper detector 12.

Also shown are lower case 15 and case 16 supporting the head assembly.

Fig. 3 is a schematic view illustrating a printing unit of the printing apparatus according to one embodiment of the invention. The printing unit comprises the print head 1 with wire holder 1a, a head carriage 1b and means for moving them.

As a method of detecting an error in the printing apparatus a method of detecting a loss of synchronism in the head carriage drive motor is described with reference to Fig. 3.

Print head 1, together with its wire holder 1a, is fixed on head carriage 1b. Head carriage 1b is driven reciprocally side to side by carriage transfer belt 32 and carriage drive gears 31a and 31b; carriage drive gear 31a is connected to a head carriage drive motor not shown in the figure. This motor is normally a pulse motor, and is a pulse motor in this embodiment. Carriage drive gear 31a drives rotating detector plate

34 via transfer gear 33. Rotating detector plate 34 is positioned so as to interrupt the detection beam of carriage detector 35, which is also a photo-interrupter. Carriage detector 35 detects the rotation of rotating detector plate 34 caused by the movement of head carriage 1b.

Note that rotating detector plate 34 is propeller-shaped, and when it rotates, the output of carriage detector 35 switches on/off on a regular period. More specifically, when head carriage 1b is driven reciprocally by the head carriage drive motor (not shown in the figure), the movement of head carriage 1b is detected by carriage detector 35.

If the receipt paper, journal paper, or slip paper between print head 1 and platen 2 is wrinkled or twisted and catches between wire holder 1a and platen 2, a paper jam occurs. As a result, head carriage 1b no longer tracks rotation of the carriage drive motor, and the carriage drive motor loses synchronization. This loss of synchronization is detected by carriage detector 35, and indicated as a "carriage error."

A "home position" for print head 1 is needed to determine a reference point for the print position. Home position detector 36 is also a photo-interrupter for detecting head carriage 1b. More specifically, when head carriage 1b moves to the left, the position at which the light beam from home position detector 36 is interrupted is the reference point for the home position.

When head carriage 1b with print head 1 moves toward the home position, home position detector 36 can detect if print head 1 does not reach the home position due to a paper jam or other factor. A home position error occurs when head carriage 1b cannot be returned to the home position.

A circuit block diagram of a control circuit suitable for implementing the present invention is shown in Fig. 4.

The mechanism of the printing apparatus of the invention as described above is represented as print head 40, motor group 41, and plunger group 42 in Fig. 4; this printer mechanism is driven by printer mechanism drive circuit 43. The printer mechanism also comprises carriage detector 44, home position detector 45, automatic cutter detector 46, paper detectors 47, and cover detectors 54, each of which is connected to central processing unit (CPU) 50.

Automatic cutter detector 46 detects the position of cutter blade 14a (Fig. 2), drives the cutter blade drive motor (not shown in the figures), and generates the detector signal at a predetermined position. If a paper jam occurs in the cutter blades, the cutter blades will not move to the specified position, the detector signal will not be output, and an error is reported. This error is called a "cutter error."

Carriage errors, home position errors, and cutter errors each result in what is generally referred to as an "error state" below.

Paper detectors 47 include near-end detector 20 (Fig. 1), receipt paper detector 12 and slip paper detector 13 (Fig. 2).

Also connected to CPU 50, which controls the entire printing apparatus, are display device 48, typically an LED unit; panel switch (form feed switch) 49 for manually advancing the paper; switch detector 75 for detecting a manual form feed caused by switch 49; interface 51 for communications with the host computer; ROM 52 for storing the control program, print character patterns, and other static information; and RAM 53 providing the receive buffer, print buffer, and other data buffers. Further connected to CPU 50 in this embodiment is a peripheral device status detector 76. It serves to detect the status of a peripheral device that may be connected to the printing apparatus. An example of such peripheral device is the cash drawer of POS and ECR systems. In some embodiments of such systems the printing apparatus is designed to connect and drive the drawer in response to corresponding commands from the host computer.

When print data is input from interface 51, the data is stored to the receive buffer of RAM 53, and CPU 50 interprets the data, reads the character patterns corresponding to the data code from ROM 52, and drives print head 40, motor group 41, and plunger group 42 by means of drive control circuit 43 to print.

When a carriage error, home position error, cutter error, or other error occurs, CPU 50 can drive display device 48 to notify the user that an error has occurred.

Fig. 5 is a function block diagram showing the overall mechanism of the invention, and the relationships between the various functional means.

Host computer 61 transmits the command data, print data, and other information to the printing apparatus. Data receiving means 62 receives the data codes from host computer 61 through interface 51, and is realized as a receive interrupt process activated through a receive interrupt by interface 51.

Real-time command interpreting means 64 interprets and real-time process execution means 73 executes received real-time commands (explained later) immediately upon their receipt by the data receiving means. As will be understood, interpretation of the received data by means 64 comprises checking whether the received data is a real-time command and, if so, which type of real-time command. Real-time command interpreting means 64 and real-time process execution means 73 are realized as part of the same receive interrupt process as that of the data receiving means 62. Thus, it will be understood

that, in the present embodiment, the data receiving means 62, the real-time command interpreting means 64 and the real-time process execution means 73 are all formed by CPU 50 as are a command interpreter 66 and a control means 68 etc.. Real-time command interpreting means 64 determines whether the received data is a real-time control command, and real-time process execution means 73 executes the specified process based on the command if the received data is determined to be a real-time control command. Real-time command interpreting means 64 and real-time process execution means 73 together will also be referred to as real-time command process means in the following.

All received data passed through real-time command interpreting means 64 is stored temporarily to receive buffer 65. The received data buffered to receive buffer 65 is read one at a time by command interpreter 66, interpreted, and separated into print data and command data for controlling the printing apparatus. Command data is applied by control means 68 to execute the settings or operations corresponding to the command code. Print data is used to store the character patterns corresponding to the data codes to print buffer 67. When printing is then executed by control means 68, control means 68 reads the character pattern from print buffer 67, and controls printer mechanism functional units 70 (mainly including print head 40, motor group 41, plunger group 42 and drive circuit 43) to print.

The RS-232C two-way, serial interface is used as the interface in this embodiment because of its ability to maintain communications with the host computer even when the printing apparatus is off-line. With the standard RS-232C two-way, serial interface, the off-line status of a device can be detected by the host computer to which the device is connected, but because several bytes of data may have been loaded to the communication bus before data transmission can be stopped, it is necessary for the off-line device to receive this data even after it moves off-line. It is therefore necessary for the device to move off-line before the receive buffer becomes full, thereby enabling data to be received and stored to the receive buffer while capacity remains even when an error occurs and the printing apparatus goes off-line. Data received after the receive buffer becomes full, however, is thrown away.

With the present embodiment of the invention, however, received commands are interpreted by real-time command interpreting means 64, which is activated by a receive interrupt, before being stored to the receive buffer. As a result, the command can be processed even if the transmitted data is not stored.

Real-time commands include commands requesting the status of the printing apparatus. When this printing apparatus status request is received, real-time command process means 64, 73 responds by sending the current printing apparatus status to host computer 61 through data transmission means 63. It remains possible to send the printing apparatus status even when an error occurs because data receiving means 62, data transmission means 63, real-time command process means 64, 73 remain functional.

When the received command is determined by command interpreter 66 to be a cut-sheet form selection command, control means 68 is notified. Control means 68 thus notifies display means 72 that a cut-sheet form was selected, displays a prompt that the printing apparatus is waiting for cut-sheet form insertion, and stores cut-sheet forms information in RAM 53 by means of cut-sheet forms status storage means 79 to indicate that a cut-sheet form was selected and that the cut-sheet form insertion wait-state was entered. When a cut-sheet form is selected, paper detector 47 detects insertion of the cut-sheet form and notifies control means 68 when the form is inserted.

Control means 68 monitors the cut-sheet form wait-state information, and stops printer mechanism drive until either the cut-sheet form wait-state information is deleted or cut-sheet form insertion is detected. By control means 68 stopping printer mechanism operation, command interpreter 66 also stops without being able to activate control means 68, but real-time command process means 64, 73 continues to operate irrespective of the cut-sheet form wait-state.

Real-time commands include a command for canceling the cut-sheet form wait-state. When this command is received, the cut-sheet form insertion wait-state information and cut-sheet form selection information stored to RAM 53 are deleted by real-time command process means 64, 73. When control means 68, which monitors the cut-sheet form insertion wait-state, recognizes that the cut-sheet form insertion wait-state information has been deleted, it cancels the cut-sheet form insertion wait-state, clears print buffer 67, and selects the default paper type. The cut-sheet form insertion wait-state can be cancelled by a time-out, and control means 68 thus controls timer 78.

If a paper jam or other error occurs during printing, paper feeding, or paper cutting, an error is detected by error detector 71, control means 68 is notified, and the error information is stored to status memory 77. Control means 68 notifies display means 72 that an error has occurred, an error notice is displayed, and the error occurrence is stored as error information to RAM 53 by error status storage means 69.

Control means 68 monitors the error information, and stops operation of the printer mechanism until the error information is cleared. By control means 68 stopping printer mechanism operation, command interpreter 66 also stops without being able to activate control means 68, but real-time command process

means 64, 73, which is activated by a receive interrupt from interface 51, continues to operate irrespective of the error. Because command interpreter 66 is stopped and no longer reads the receive buffer, however, the data received by interface 51 is simply stored to receive buffer 65, and control means 68 therefore controls the interface to notify the host computer that the printing apparatus cannot accept anymore information (i.e., notifies the host computer that the printing apparatus is now off-line).

The real-time commands also include a 'recover from error' command. When this command is received, real-time command process means 64, 73 deletes the error information stored to RAM 53. When control means 68, which monitors this error status information, recognizes that the error information was deleted, it reactivates the printing apparatus to resume printing.

Another 'recover from error' command is a command to resume printing after deleting all previously received data. When this command is received, receive buffer 65 and print buffer 67 are cleared by real-time command process means 64, 73, and the error information stored in RAM 53 is then deleted.

The printing apparatus also goes off-line when a no-paper state is detected by paper detector 47, when an open-cover state is detected by cover detector 54, or when a manual form feed caused by the form feed switch (49 in Fig. 4) is detected by switch detector 75. These states are stored to status memory 77, and the information is reported to host computer 61 by real-time command process means 64, 73 via data transmission means 63.

Fig. 6 shows the command code for real-time commands in the present embodiment. Referring to Fig. 6, received data [GS], [R], and [n] are each one byte long, expressed as 1D, 52, and n in hexadecimal code. [GS] and [R] indicate a real-time command 80; what is executed is selected according to the value of [n], i.e. the command's parameter 81.

The values of [n] and what is executed for each [n] value in this embodiment are shown in Table 1.

When [n] = 0, the printing apparatus status byte (one byte) shown in Table 2 is sent to the host computer. The drawer status, and printing apparatus on-line/off-line status can be determined by the host computer based on the printing apparatus status information. When the printing apparatus is off-line, more specific off-line information can be obtained by setting [n] to 1.

When [n] = 1, the off-line information byte (one byte) shown in Table 3 is sent to the host computer. The host computer can thus evaluate the off-line information, and can post prompts or other appropriate information to the user based on the evaluation result. If an error is determined to have occurred, detailed error information can be obtained by setting [n] to 2.

When [n] = 2, the error information byte (one byte) shown in Table 4 is sent to the host computer. The mechanical errors shown in Table 4 refer primarily to errors due to a paper jam, but also include carriage errors and home position errors. These are further distinguished as paper jams around the print head and automatic paper cutter errors, thereby enabling the host computer to distinguish between paper jams occurring around the print head and in the automatic paper cutter. Based on this determination, the user is appropriately notified using the display means of the host computer where the error occurred, thus facilitating removal of the paper jam.

Printing can be resumed when paper jam errors and similar errors occur by removing the paper jam or other error cause. Errors can also occur as a result of external power supply problems, damage to the print head temperature detector, and other causes making resumption of printing difficult, and it is necessary to distinguish these non-recoverable errors from recoverable errors (from which printing can be resumed). Errors other than paper jam errors are therefore identified as non-recoverable errors by setting bit 5.

When [n] = 3, the continuous paper (incl. journal and receipt paper) detector information byte (one byte) shown in Table 5 is sent to the host computer.

When [n] = 4, the slip paper detector information byte (one byte) shown in Table 6 is sent to the host computer. It is possible to determine from this slip status byte shown in Table 6 whether slip paper is selected or whether continuous or validation paper is selected. It is also possible to determine, when slip paper is selected, whether the printing apparatus is waiting for slip paper insertion, or whether the paper has already been loaded and printing can proceed.

When [n] = 5, the validation paper detector information byte (one byte) shown in Table 7 is sent to the host computer. It is possible to determine from this validation paper status byte shown in Table 7 whether validation paper is selected or whether continuous or slip paper is selected. It is also possible to determine, when validation paper is selected, whether the printing apparatus is waiting for validation paper insertion, or whether the paper has already been loaded and printing can proceed.

The data receiving means 62, the real-time command interpreting means 64 and the real-time process execution means 73 are described below with reference to Figs. 7 and 8.

Fig. 7 shows the printing apparatus initialization process, which starts immediately after the power is turned on (step 120). During this initialization, the printer mechanism is initialized (step 121), and all

information in RAM 53 is initialized, including the cut-sheet form status flag, error information, clear-buffer flag, GS flag, and GSR flag (step 122). The clear-buffer flag, GS flag, and GSR flag are used in the receive interrupt process as will be explained in detail later. In the final step 124, interface receive interrupts are enabled, and the initialization process is ended (step 124).

Fig. 8 shows the receive interrupt process executed by the data receiving means 62, the real-time command interpreting means 64 and the real-time process execution means 73. The data received from the host computer through the interface is received one byte at a time, and the process shown in Fig. 8 is executed for every byte received. Because the real-time commands comprise three bytes, [GS], [R], and [n], as shown in Fig. 6, each real-time command is controlled by the GS flag, which is set when the [GS] byte is received; the GSR flag, which is set when the [R] byte is received and the GS flag is set; and the [n] byte received when the GSR flag is set. There is also a clear-buffer flag, which stores whether the buffer is cleared according to the value of [n].

Data is received and the receive interrupt is activated at step 125. At step 126, the received data is read from the interface, and at step 127 it is determined whether the GSR flag is set. If the GSR flag is set, i.e., if the [GS] and [R] bytes have already been received, the received data ("C" in this example) is processed with the value of [n]. The GSR flag is cleared at step 136, and the following operation is executed based on the value of the received data (C) (step 137).

If C = 0, the printer information stored in RAM 53 is sent through the interface to the host computer by data transmission means 63 (step 138).

If C = 1, the off-line information stored in RAM 53 is sent through the interface to the host computer by data transmission means 63 (step 139).

If C = 2, the error information stored in RAM 53 is sent through the interface to the host computer by data transmission means 63 (step 140).

If C = 3, the continuous paper information stored in RAM 53 is sent through the interface to the host computer by data transmission means 63 (step 141).

If C = 4, the slip paper information stored in RAM 53 is sent through the interface to the host computer by data transmission means 63 (step 142).

If C = 5, the validation paper information stored in RAM 53 is sent through the interface to the host computer by data transmission means 63 (step 143).

If C = 6, it is determined whether the cut-sheet form insertion wait-state is set (step 144), and if so, the cut-sheet form wait flag is cleared (step 145). As shown in Fig. 9, the system can recover from the cut-sheet form insertion wait-state by clearing the cut-sheet form wait flag.

If C = 8, the clear-buffer flag is set (step 146), and the error information in RAM 53 is cleared (step 147). When the clear-buffer flag is cleared, the receive buffer and print buffer are both cleared as shown in Fig. 10 after error recovery. If C = 7, the error information is simply cleared (step 147).

The received data is also temporarily stored to the receive buffer even if the data is a real-time command (step 132).

If the GSR flag is cleared in step 127, it is determined in step 128 whether the GS flag is set. Specifically, if the data has been received immediately following the [GS] byte, the GS flag is set; the GS flag is therefore cleared in step 129, and it is determined whether the received data (C) is the [R] byte (step 129). If C = [R], the GSR flag is set (step 131), and the received data is stored to the receive buffer (step 132).

If the GS flag is cleared in step 128, it is determined in step 134 whether the received data (C) is the [GS] code. If C = [GS], the GS flag is set; if not, the data is stored directly to the receive buffer (step 132), and the receive interrupt process is ended (step 133).

The operation of the control means for setting cut-sheet forms is described next with reference to Fig. 9. Shown in Fig. 9 are the process from selection of cut-sheet form printing to loading the paper, and the process for cancelling the cut-sheet form print mode selection.

This process starts (step 151) when command interpreter 66 determines that the input command is the cut-sheet form selection command, thus causing command interpreter 66 to set the cut-sheet form selection flag, and the cut-sheet form insertion wait flag (step 152). After confirming that mechanical operations are stopped (step 153), cut-sheet form insertion wait timer 78 is activated, and display device 48 is set flashing by display means 72 (step 155). In step 156 it is determined whether the cut-sheet form insertion wait flag is cleared; if so, i.e., if the cut-sheet form insertion wait-state is cancelled by real-time command [GS] [R] [6], the cut-sheet form insertion wait timer 78 is stopped (step 157), and display device 48 is turned off by display means 72 (step 158). The cut-sheet form selection flag and cut-sheet form insertion wait flag are then cleared (step 159), the paper corresponding to the default paper type setting is set (step 160), and the

cut-sheet form selection process is ended (step 161).

If the cut-sheet form insertion wait flag is not cleared in step 156, it is determined if the cut-sheet form insertion wait period has passed (step 162); if the cut-sheet form insertion wait period has passed, the procedure skips forward to step 158.

If the cut-sheet form insertion wait period has not passed in step 162, it is determined in step 163 whether the cut-sheet form is inserted. If the cut-sheet form is not inserted, the procedure loops back to step 156 to determine again whether the cut-sheet form insertion wait flag is cleared. The procedure then determines again whether the cut-sheet form insertion wait flag is cleared, whether the cut-sheet form insertion wait period has passed, and whether the cut-sheet form is inserted.

If it is determined in step 163 that the cut-sheet form was inserted, the cut-sheet form insertion wait timer 78 is stopped (step 164), display device 48 is turned on (step 165), and the start-operation standby period is waited (step 166). If it is determined in step 167 that the cut-sheet form is not inserted, the procedure loops back to step 154, and the above operation is repeated.

If it is determined in step 167 that the cut-sheet form is loaded, the cut-sheet form insertion wait flag is cleared (step 168), the cut-sheet form is set to the correct position (step 169), and the cut-sheet form selection process ends (step 161).

As described hereinabove, by providing a data receiving means and a real-time command process means in the receive interrupt process, it is possible to interpret commands and cancel the cut-sheet form wait-state even when the printer mechanism is stopped due to a cut-sheet form insertion wait-state.

A means of detecting carriage errors is described below as an embodiment of the invention for detecting errors with reference to Fig. 10.

The process is started in step 101 by the print command, and the printing apparatus is initialized for one line in step 102. The line is then printed from steps 103 to 105. In step 103, one dot row is printed and the head carriage is advanced one dot row. In step 104, it is determined whether a detector pulse was output from carriage detector 35 due to carriage movement; the detector pulse is usually output on a regular cycle if the carriage advances normally. In step 105, it is determined whether printing the one line is completed; if not, the procedure loops back to step 103. If the one row is completed, the procedure then ends at step 106.

If the carriage is stopped at this time due to, for example, a paper jam, the detector pulse is not detected at step 104, and the procedure branches to step 107. The procedure from step 107 is the process executed when a carriage error occurs, and the first step (step 107) is to notify the host computer that the printing apparatus cannot receive further communication data, i.e., that it is off-line. That a carriage error has occurred is then stored to RAM 53 in step 108. Because a carriage error is a recoverable error, the error is stored as a recoverable error. The printer mechanism is also stopped in step 109.

That an error occurred is then displayed (step 110) by the display device 48 until it is determined in step 111 that the error information has been deleted. If a corresponding real-time command is received, the error information is deleted, and it is determined in step 112 whether the received command indicates a clear buffer operation. If a clear buffer command has been received, the buffer is cleared in step 113; the buffers cleared at this time are both the receive buffer and print buffer.

A printer mechanism reset operation is then executed in step 114, and the host computer is notified in step 115 that the printing apparatus can again receive data, i.e., is again on-line.

By thus including a data receiving means and real-time command process means within the receive interrupt process, it is possible to continue interpreting commands when the printer mechanism stops due to an error, and recovery from errors is therefore also possible.

Control of the printing apparatus as seen from the host computer is described next.

Fig. 11 is a conceptual diagram of the data processing apparatus of the invention in which printing apparatus 300 is connected with host computer 61 by means of an RS-232C communication cable 301. Host computer 61 comprises an internal communication means 304 and an RS-232C interface control circuit. A CRT or other display device 302, and keyboard or other input device 303 are also connected to host computer 61.

Fig. 12 is a flow chart of the control process of the host computer allowing cancellation of the cut-sheet form wait-state. Printing to slip paper is used as an example of cut-sheet form printing in Fig. 12.

When slip paper printing is selected (step 250), the slip paper selection command is output (step 251). Real-time command [GS] [R] [4] is then sent to determine the slip paper status (step 252), and the corresponding response is received (step 253). This response contains the information shown in Table 6. Based on this information, the host computer determines whether slip paper has been selected (step 254).

If slip paper has been selected, it is determined based on the information from step 253 whether the printing apparatus is waiting for slip paper insertion (step 255). If it is not waiting, it is first determined

whether the slip paper is loaded (step 256); if so, the print data is output (step 257), and slip paper printing is completed (step 258).

If step 255 returns that the printing apparatus is waiting for slip paper insertion, the host computer monitors a specific key in input device 303, e.g., a "cancel slip paper" key, and determines whether this key is pressed (step 259). This key is specifically assigned the "cancel slip paper wait-state" function, and has to be operated by the user if he or she wants the slip paper selection cancelled.

If the key is pressed, the "cancel slip paper wait-state" command [GS] [R] [6] will be output to cancel the slip paper wait-state (step 260).

It is also possible to terminate slip paper printing (step 259) by monitoring this key when slip paper printing has been previously instructed but the command has not yet been executed, i.e., slip paper is not selected yet (step 254), or when there is no paper (step 256). In these cases, sending the "cancel slip paper wait-state" command [GS] [R] [6] (step 260) will be ignored because the printing apparatus is not in the cut-sheet form insertion wait-state. If the key is not pressed, the process loops back to step 252, and the host computer waits for slip paper selection (step 254) or until the slip paper is loaded (step 256).

Fig. 13 is a flow chart of the printing process in the host computer allowing for error recovery.

After printing has started (step 200), the host computer checks whether the printing apparatus is still on-line (step 202) each time after one line of print data has been sent to the printing apparatus (step 201). In general, it is possible to determine with the RS-232C interface whether the receiving side (the printing apparatus in this case) is on-line from the CTS (Clear To Send) signal, the DSR (Data Set Ready) signal, or the XOFF code. If the printing apparatus is on-line, the host computer continues to send the print data. If there is no more print data (step 203), printing ends (step 204).

If in step 202 the printing apparatus is off-line, it is possible that an error has occurred in the printing apparatus, or that printing has been disabled by some other factor (e.g., there is no more printing paper). To determine whether an error has occurred, the host computer sends real-time command [GS] [R] [2] in step 205. The response to this command is received in step 206, and used to determine (in step 207) whether an error occurred.

If an error did not occur, the printing apparatus may be off-line for some reason other than an error; this reason is therefore investigated (step 208), and the appropriate action is taken (step 209). To determine this reason, the host computer outputs real-time command [GS] [R] [1], and receives in response information that, for example, the cover is open or that there is no paper. The host computer can then display a user prompt such as "please close the cover" or "please add paper" on display device 302 to aid the user in correcting the problem.

This sequence is repeated until the printing apparatus comes on-line again (step 210), at which point printing is resumed from step 201.

If step 207 determines that an error has occurred, it is determined whether the error is recoverable (step 211); this determination is based on the bit 5 value shown in Table 4. If the error is recoverable, the user is notified that an error has occurred, and can be requested to check the expected cause of the error, e.g., a paper jam. The location of the paper jam can also be reported to the user as being in the carriage or the automatic paper cutter based on the state of bits 2 and 3 in Table 4. After the user corrects the paper jam, the user confirms that the cause of the error has been corrected using input device 303 (e.g., a keyboard) of the host computer (step 213). Real-time command [GS] [R] [6] or [7] is then output to reset the printing apparatus from the error. Because it is possible that the user has not completely corrected the cause of the error, or that plural errors occurred simultaneously, the process after error recovery will preferably resume from step 205 to check again for errors.

If step 211 determines that the error is non-recoverable, there is a problem in the printing apparatus that may not be correctable by the user. In this case, the user is informed that there is a problem in the printing apparatus (step 215), and printing is stopped (step 216).

In a data processing apparatus such as POS and ECR terminals where monetary transactions are handled, data loss and duplication are impermissible. When an error occurs in the printing apparatus, it is important to recover from the error without destroying the data already received, and to resume printing. However, to maintain compatibility with data processing apparatuses using printing apparatuses according to the prior art, a mode for recovering after deleting the already received data is also enabled, and this mode can be selected by a control command from the host computer. More specifically, in data processing apparatuses using printing apparatuses according to the prior art, the data already received is always destroyed after the printing apparatus recovers from the error. When the same data is printed after error recovery as before the error occurred, a special character is printed at the beginning of the line to indicate that the data in that line has been printed twice. A mode for error recovery after destroying the data already received is therefore necessary to maintain compatibility with this operation.

By means of the invention thus described, the host computer can determine why the printing apparatus has gone off-line while the printing apparatus is off-line.

Furthermore, by providing a data receiving means and real-time command process means in the receive interrupt process, commands can be interpreted and recovery from a cut-sheet form insertion wait-state is possible even during the cut-sheet form insertion wait-state.

In addition, when the cause of the off-line status is an error, the host computer can determine whether the error is recoverable; if it is recoverable, the user can be notified where the error occurred, and printing can be resumed without destroying the data already received once the cause of the error is corrected.

When recovering from an error, it is also possible to choose to resume printing after destroying the data already transmitted to the printing apparatus, or to resume printing from the line at which the error occurred.

As a result, it is possible to provide a printing apparatus featuring high reliability and a high throughput rate; to provide a user-friendly printing apparatus reducing the host computer overhead; and to provide a data processing apparatus using said printing apparatuses for use as a printing apparatus used in monetary transactions in the distribution industry.

Table 1

n	What is executed
0	Send printer status
1	Send the cause of the off-line state
2	Send the cause of the error
3	Send the status of the continuous forms detector
4	Send the status of the slip paper detector and slip paper
5	Send the status of the validation paper detector and validation paper
6	Cancel cut-sheet form insertion wait-state
7	Recover from error (resume printing)
8	Recover from error (clear buffers)

Table 2

(n = 0: Printer Status)			
Bit	Function	Value	
		0	1
0	Reserved	Fixed to 0	
1	Reserved	Fixed to 1	
2	Drawer connector	LOW	HIGH
3	On-line/off-line status	on-line	off-line
4	Reserved	Fixed to 1	
5	Undefined		
6	Undefined		
7	Reserved	Fixed to 0	

Table 3

(n = 1; Off-line Cause Status)			
Bit	Function	Value	
		0	1
0	Reserved	Fixed to 0	
1	Reserved	Fixed to 1	
2	Cover status	Closed	Open
3	Form feed by form feed switch	Form feed not in progress	Form feed in progress
4	Reserved	Fixed to 1	
5	No paper: printing stopped	Printing not stopped	Printing stopped
6	Error status	No error	Error generated
7	Reserved	Fixed to 0	

Table 4

(n = 2: Error Cause Status)			
Bit	Function	Value	
		0	1
0	Reserved	Fixed to 0	
1	Reserved	Fixed to 1	
2	Mechanical error	No error	Error generated
3	Automatic paper cutter error	No error	Error generated
4	Reserved	Fixed to 1	
5	Non-recoverable error	No error	Error generated
6	Auto-recover error	No error	Error generated
7	Reserved	Fixed to 0	

Table 5

(n = 3: Continuous Paper Detector Status)			
Bit	Function	Value	
		0	1
0	Reserved	Fixed to 0	
1	Reserved	Fixed to 1	
2	Journal near-end detector	Paper loaded	No paper
3	Receipt near-end detector	Paper loaded	No paper
4	Reserved	Fixed to 1	
5	Journal end detector	Paper loaded	No paper
6	Receipt end detector	Paper loaded	No paper
7	Reserved	Fixed to 0	

Table 6

(n = 4: Slip Paper Status)			
Bit	Function	Value	
		0	1
0	Reserved	Fixed to 0	
1	Reserved	Fixed to 1	
2	Slip paper selection	Selected	Not selected
3	Slip paper insertion wait-state	Waiting	Not waiting
4	Reserved	Fixed to 1	
5	Slip paper detector	Paper loaded	No paper
6			
7	Reserved	Fixed to 0	

Table 7

(n = 5: Validation Paper Status)			
Bit	Function	Value	
		0	1
0	Reserved	Fixed to 0	
1	Reserved	Fixed to 1	
2	Validation paper selection	Selected	Not selected
3	Validation paper insertion wait-state	Waiting	Not waiting
4	Reserved	Fixed to 1	
5	Validation paper detector	Paper loaded	No paper
6			
7	Reserved	Fixed to 0	

Claims

1. A printing apparatus having a printer mechanism (40, 41, 42) for printing to a print medium and control means (50) for controlling the printer mechanism in response to received data transmitted from a host device (61), said received data including control commands and print data, said control means comprising:

receiving means (62) for receiving said data;

receive buffer means (65) for storing at least the control commands among said received data;

first control command interpreting means (64) for interpreting said received data;

second control command interpreting means (66) for reading and interpreting the data in the receive buffer means (65) in a first-in-first-out order;

process execution means (68, 73) for executing respective processes corresponding to the control commands among the data interpreted by said first and second control command interpreting means (64, 66);

device-condition detection means (47, 54, 69, 71, 75, 76, 77, 79) for detecting the conditions of the printing apparatus (300); and

a transmission means (63) for transmitting data to the host device (61)

wherein the process execution means (68, 73) executes a process corresponding to a control command interpreted by said first control command interpreting means with priority over a process corresponding to a control command interpreted by said second control command interpreting means, and comprises a device-condition reporting means for reporting the data obtained by the device-condition detection means to the transmission means..

2. A printing apparatus according to claim 1 wherein the process execution means comprises:

first process execution means (73) for executing the process corresponding to a control command interpreted by the first control command interpreting means (64); and

a second process execution means (68) for executing the process corresponding to a control command interpreted by the second control command interpreting means;

wherein the first process execution means (73) executes the required process while interrupting the operation of the second process execution means (68).

3. A printing apparatus according to claim 1 or 2, further comprising:

a cover member which covers the printer mechanism (40, 41, 42) when closed, and exposes the printer mechanism when open;

wherein the device-condition detection means comprises a cover member detection means (54) for detecting the open/closed state of the cover member.

4. A printing apparatus according to any one of claims 1 to 3, further comprising:
a peripheral device connecting means for connecting a peripheral device to be controlled based on the control commands;
wherein the device-condition detection means comprises a detection means (76) for detecting the state of the peripheral device connecting means.

5. A printing apparatus according to any one of claims 1 to 4, wherein:
the device-condition detection means comprises a print medium detection means (47) for detecting the presence and/or the remaining amount of available print medium.

6. A printing apparatus according to any one of claims 1 to 5, wherein:
the device-condition detection means comprises a set-state detection means for detecting the settings of the printing apparatus.

7. A printing apparatus according to claim 6 further comprising:
a continuous sheet transport means (6a, 6b) for transporting and supplying a continuous print medium (17) to a printing means (1, 1a, 2) of the printer mechanism (40, 41, 42);
a cut-sheet transport means (8a, 8b, 9a, 9b) for transporting and supplying cut-sheet print media (19) to the printing means; and
a cut-sheet selection means for prohibiting or permitting operation of the cut-sheet transport means; and
the set-state detection means comprising a cut-sheet selection detection means (79) for detecting the state of the cut-sheet selection means.

8. A printing apparatus according to any one of claims 1 to 7, wherein:
the device-condition detection means comprises an operating-state detection means for detecting the operating state of the printing apparatus.

9. A printing apparatus according to claim 8 further comprising:
a cut-sheet transport means (8a, 8b, 9a, 9b) for transporting and supplying cut-sheet print media (17) to a printing means (1, 1a, 2) of the printer mechanism (40, 41, 42); and
a cut-sheet transport control means (68) for waiting until a cut-sheet print medium is supplied to the cut-sheet transport means, and then beginning print medium transportation by the cut-sheet transport means;
wherein the operating-state detection means comprises a cut-sheet transport state detection means (79) for detecting the state of the cut-sheet transport control means.

10. A printing apparatus according to claim 8 or 9 wherein:
the operating-state detection means comprises a data storage state detection means for detecting the state of the receive buffer means (65).

11. A printing apparatus according to any one of claims 8 to 10, further comprising:
a print medium transport switch (49) for requesting execution of the print medium transport operation independently of the control command;
wherein the operating-state detection means comprises a transport switch detection means (75) for detecting the state of the print medium transport switch.

12. A printing apparatus according to any one of claims 8 to 11, wherein:
the operating-state detection means comprises an error state detection means for detecting an error state of the printing apparatus.

13. A printing apparatus according to claim 12 wherein:
the error state detection means comprises a recovery evaluation means for determining whether the error state is recoverable.

14. A printing apparatus according to claim 12 or 13, further comprising:
an error state flag storage means (69) for storing error state flags set according to the occurrence of error states;

the second process execution means (68) being controlled to stop process execution while the error state flag is set; and

the first process execution means (73) comprising an error state flag resetting means for resetting the error state flag.

15. A printing apparatus according to claim 14 wherein:

the first process execution means (73) further comprises a received data cancellation means for cancelling the received data, stored in the receive buffer means (65).

16. A printing apparatus according to claim 2 further comprising:

a cut-sheet transport means (8a, 8b, 9a, 9b) for transporting and supplying cut-sheet print media (19) to a printing means (1, 1a, 2) of the printer mechanism (40, 41, 42);

a cut-sheet transport control means (68) for waiting until a cut-sheet print medium is supplied to the cut-sheet transport means, and then beginning print medium transportation by the cut-sheet transport means; and

a cut-sheet transport state detection means (79) for detecting the state of the cut-sheet transport control means;

wherein the first process execution means (73) comprises a cut-sheet supply wait-state cancellation means for cancelling operation of the cut-sheet transport control means when the cut-sheet supply wait-state of the cut-sheet transport control means is detected by the cut-sheet transport state detection means.

17. A method of controlling a printing apparatus in response to received data transmitted from a host device for printing to a print medium, said received data including control commands and print data;

said control method comprising:

a receiving step for receiving said data;

a received data storing step for storing at least the received control commands among said received data;

a first control command interpreting step for interpreting said received data;

a second control command interpreting step for reading and interpreting the stored received data in a first-in-first-out order;

a process executing step for executing the respective processes corresponding to the control commands based on the interpreted results of the first and second control command interpreting steps; and

a device-condition detection step for detecting the condition of the printing apparatus;

wherein the process execution step executes a process corresponding to a control command interpreted by the first control command interpreting step with priority over a process corresponding to a control command interpreted by the second control command interpreting step and wherein the process execution step comprises a transmission step for transmitting the data obtained by the device-condition detection step to the host device.

18. The method according to claim 17 wherein the process execution step comprises:

a first process execution step for executing the processes corresponding to control commands interpreted by the first control command interpreting step; and

a second process execution step for executing the process corresponding to control commands interpreted by the second control command interpreting step;

wherein the first process execution step executes the required process while interrupting the second process execution step.

19. The method according to claim 18, further comprising:

an error state flag storing step for setting and storing an error state flag when an error state is detected in the device-condition detection step;

wherein the second process execution step stops process execution while the error state flag is set; and

the first process execution step comprises an error state flag resetting step for resetting the error state flag.

20. The method according to claim 18 or 19 wherein the first process execution step further comprises a received data cancellation step for cancelling the stored received data.

21. The method according to claim 18, 19 or 20, further comprising:

a cut-sheet transport step for waiting until a cut-sheet print medium is supplied, and starting transporting to supply the cut-sheet print medium to a printing means of the printer mechanism (40, 41, 42);

wherein the first process execution step comprises a cut-sheet supply wait-state cancellation step for canceling the cut-sheet transport step when the cut-sheet transport step is in the cut-sheet transport wait-state.

22. A data processing apparatus comprising:

a printing apparatus according to any one of claims 1 to 16; and

a host device (61) for sending said data, including control commands and print data, to the printing apparatus, and wherein:

said host device comprises:

command transmission means for transmitting to the printing apparatus (300) a report device-condition command,

said command being a control command requesting transmission of the device condition detection data, and being interpretable by the first control command interpreting means.

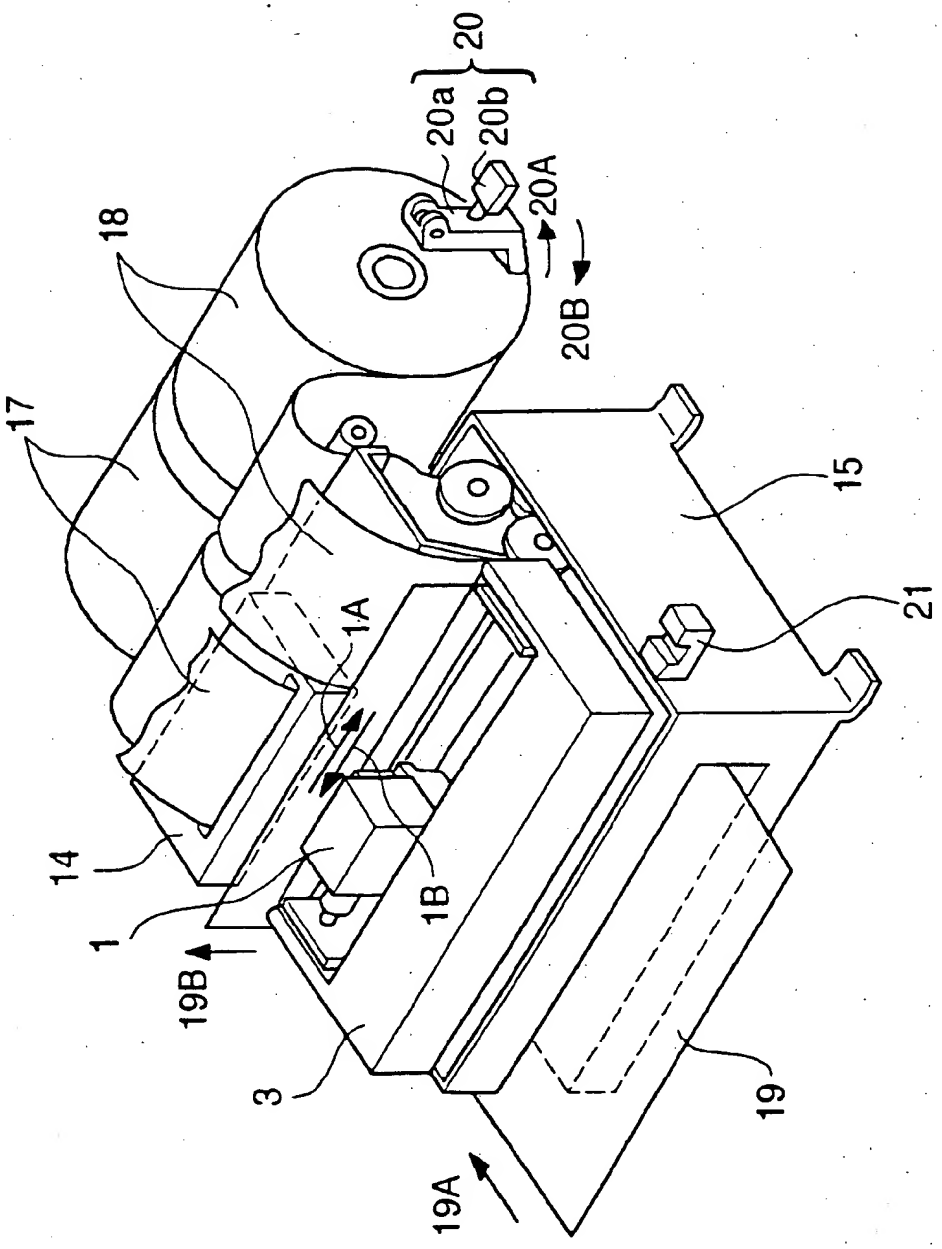

FIG. 1

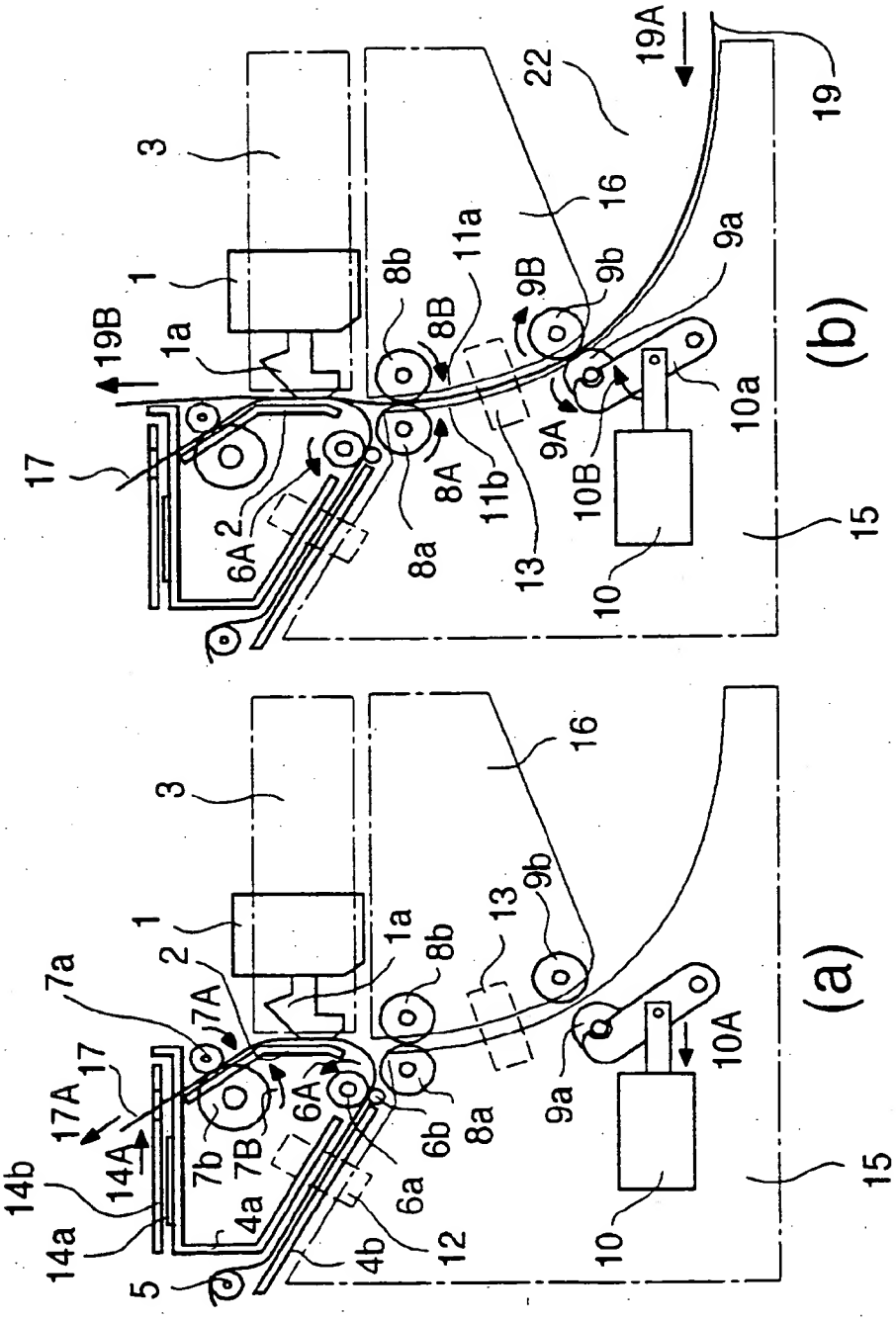
(a)
(b)
1
1a
2
3
4a
4b
5
6A
6a
6b
7a
7A
7b
7B
8a
8b
8A
8B
9a
9b
9A
9B
10
10A
10B
10a
11a
11b
12
13
14a
14b
14A
15
16
17
17A
19
19A
19B
22

FIG. 2

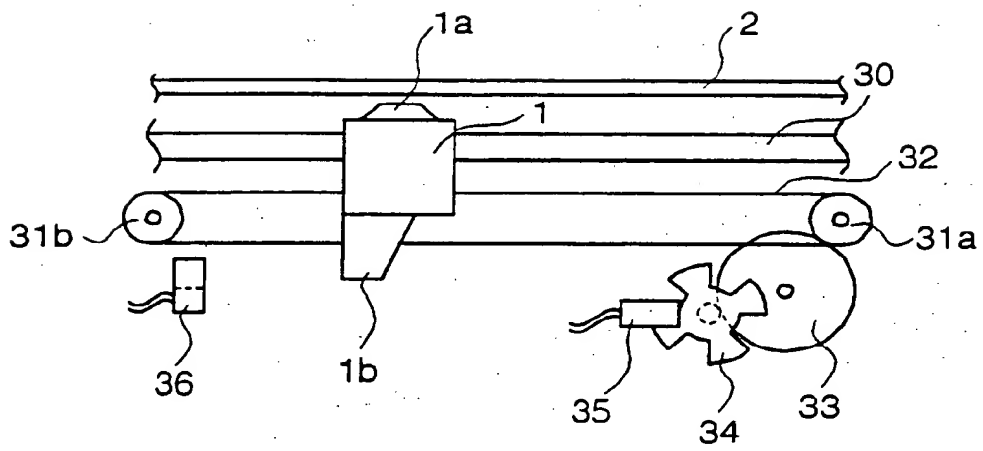

FIG.3

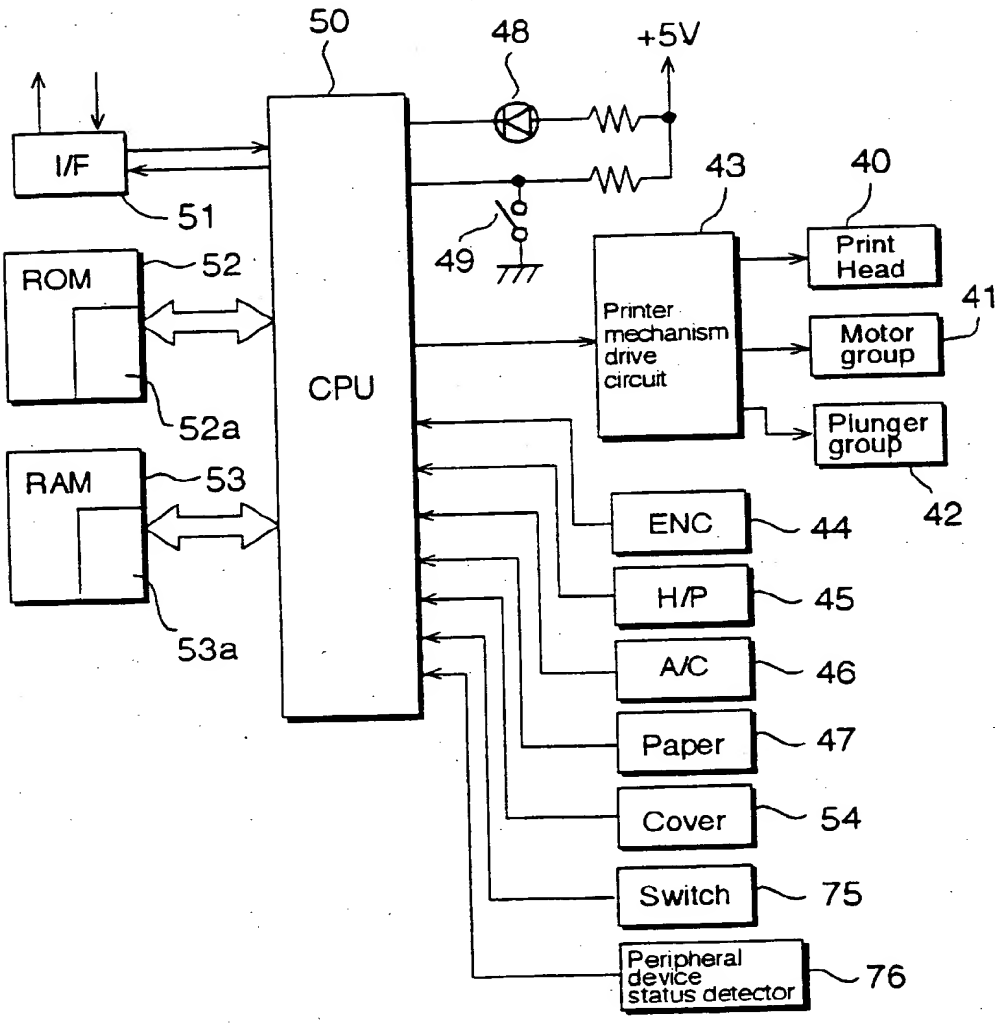

FIG. 4

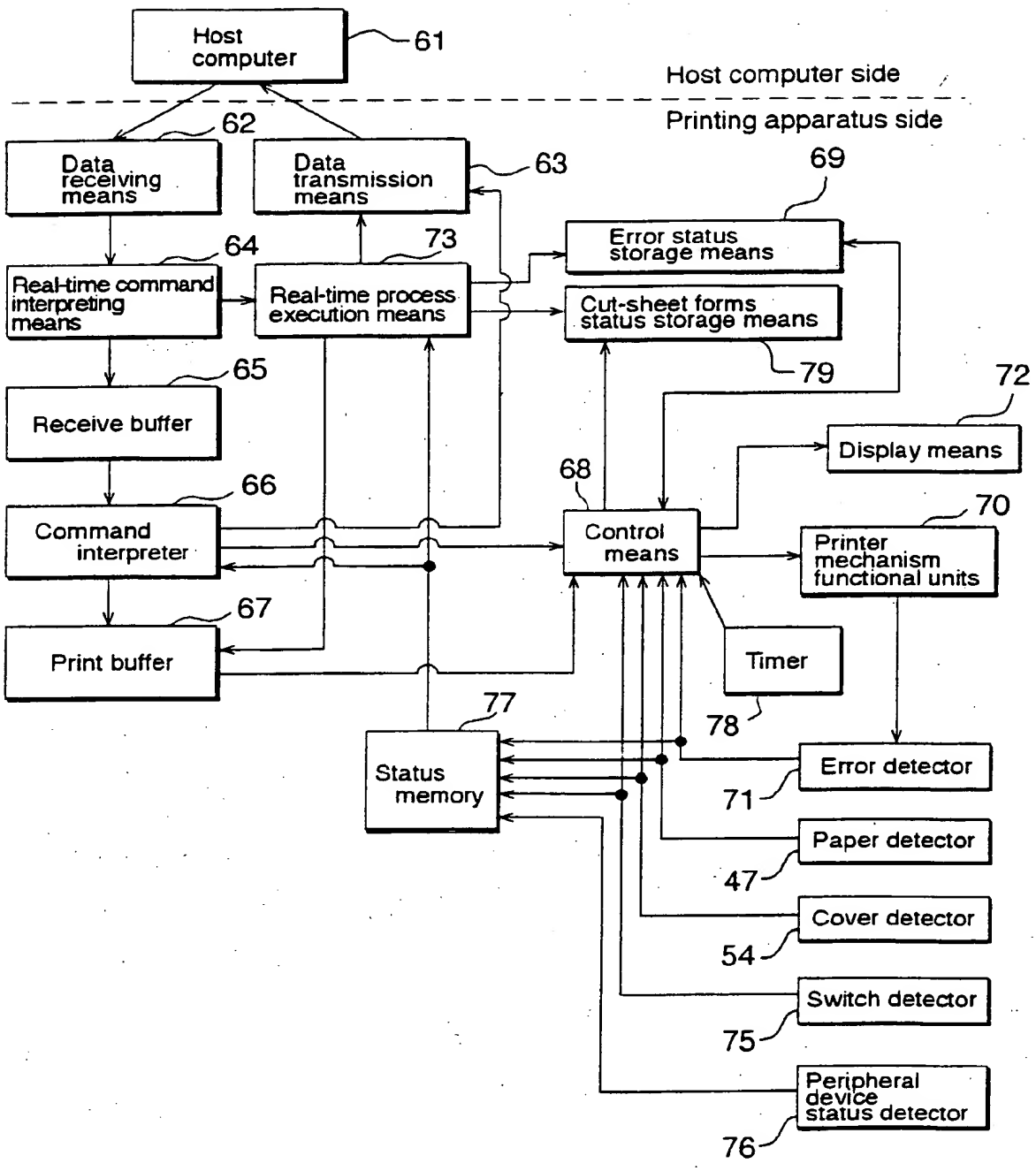
Host computer
61
Host computer side
Printing apparatus side
62
Data receiving means
Data transmission means
63
69
Error status storage means
64
73
Real-time command interpreting means
Real-time process execution means
Cut-sheet forms status storage means
79
65
72
Receive buffer
Display means
68
66
70
Command interpreter
Control means
Printer mechanism functional units
67
Print buffer
Timer
78
77
Status memory
Error detector
71
Paper detector
47
Cover detector
54
Switch detector
75
Peripheral device status detector
76

FIG. 5

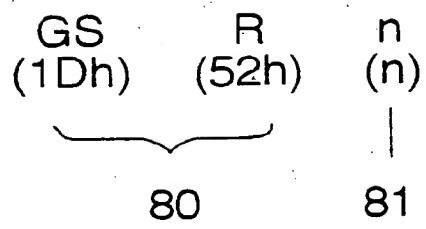

FIG. 6

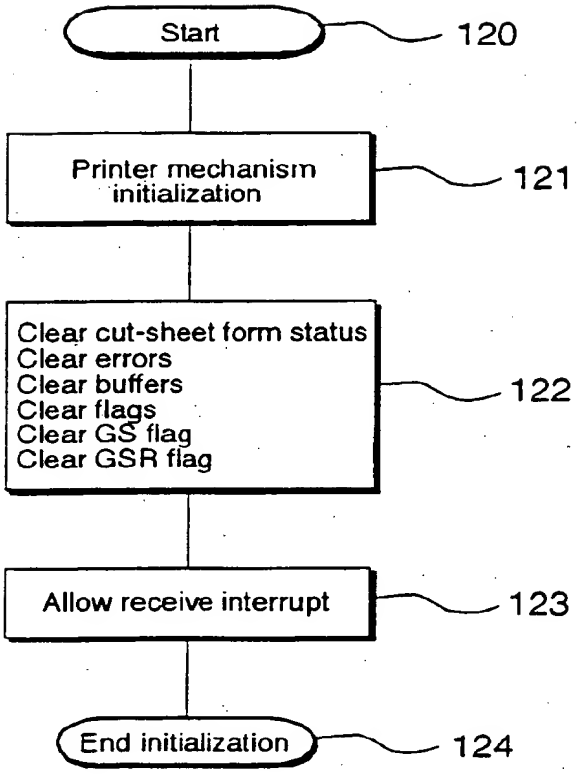
Start
120
Printer mechanism initialization
121
Clear cut-sheet form status
Clear errors
Clear buffers
Clear flags
Clear GS flag
Clear GSR flag
122
Allow receive interrupt
123
End initialization
124

FIG. 7

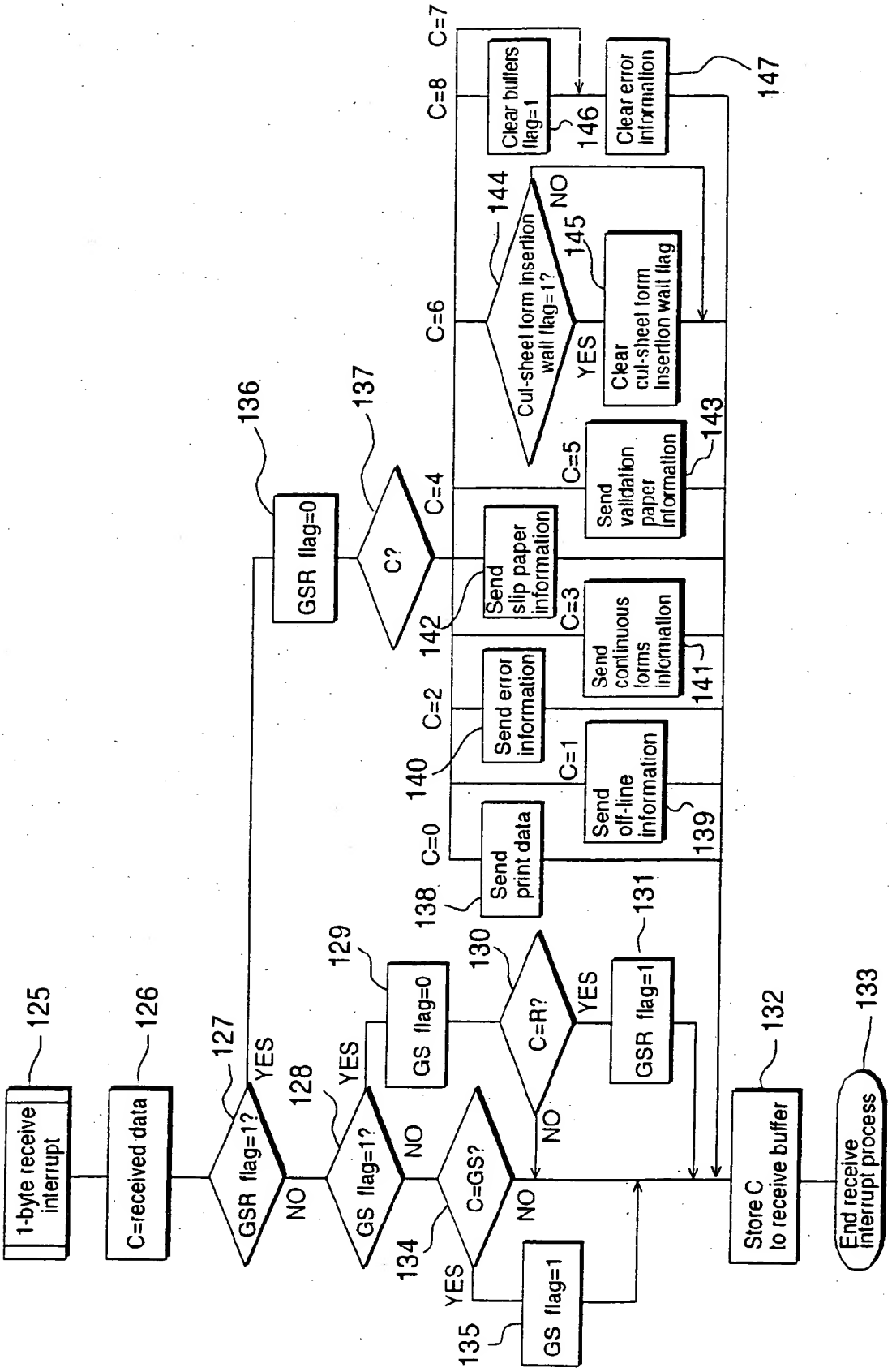
1-byte receive interrupt
125
C=received data
126
GSR flag=1?
127
YES
NO
GS flag=1?
128
YES
NO
GS flag=0
129
C=R?
130
YES
NO
GSR flag=1
131
C=GS?
134
YES
NO
GS flag=1
135
Store C to receive buffer
132
End receive interrupt process
133
GSR flag=0
136
C?
137
C=4
C=3
C=2
C=1
C=0
Send slip paper information
142
Send continuous forms information
141
Send error information
140
Send off-line information
139
Send print data
138
C=6
C=5
Cut-sheet form insertion wait flag=1?
144
NO
YES
145
Clear cut-sheet form insertion wait flag
Send validation paper information
143
C=8
C=7
Clear buffers flag=1
146
Clear error information
147

FIG. 8

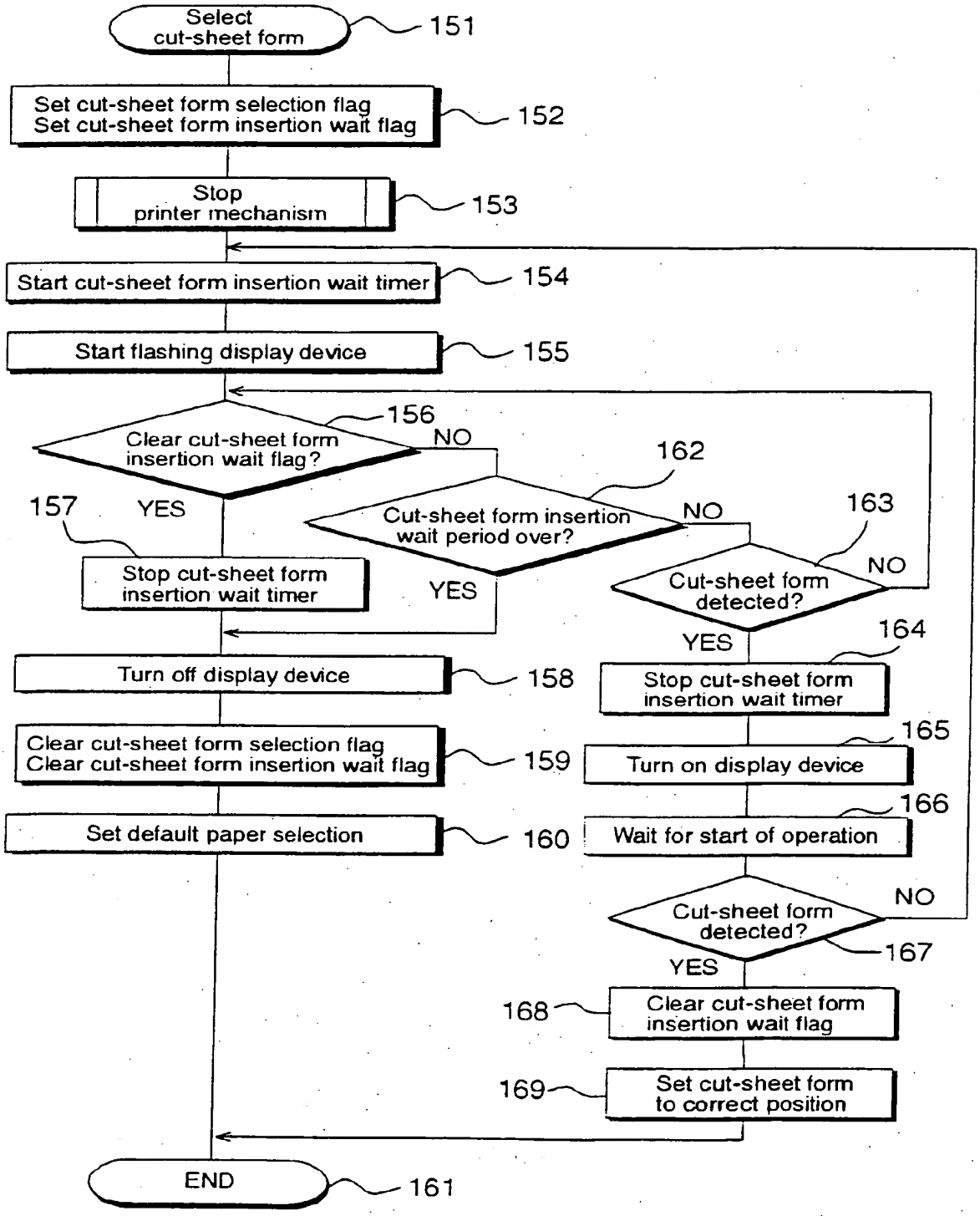
Select cut-sheet form
151
Set cut-sheet form selection flag
Set cut-sheet form insertion wait flag
152
Stop printer mechanism
153
Start cut-sheet form insertion wait timer
154
Start flashing display device
155
156
Clear cut-sheet form insertion wait flag?
NO
YES
157
Stop cut-sheet form insertion wait timer
162
Cut-sheet form insertion wait period over?
NO
YES
163
Cut-sheet form detected?
NO
YES
164
Stop cut-sheet form insertion wait timer
Turn off display device
158
Clear cut-sheet form selection flag
Clear cut-sheet form insertion wait flag
159
Turn on display device
165
Set default paper selection
160
Wait for start of operation
166
Cut-sheet form detected?
NO
YES
167
168
Clear cut-sheet form insertion wait flag
169
Set cut-sheet form to correct position
END
161

FIG. 9

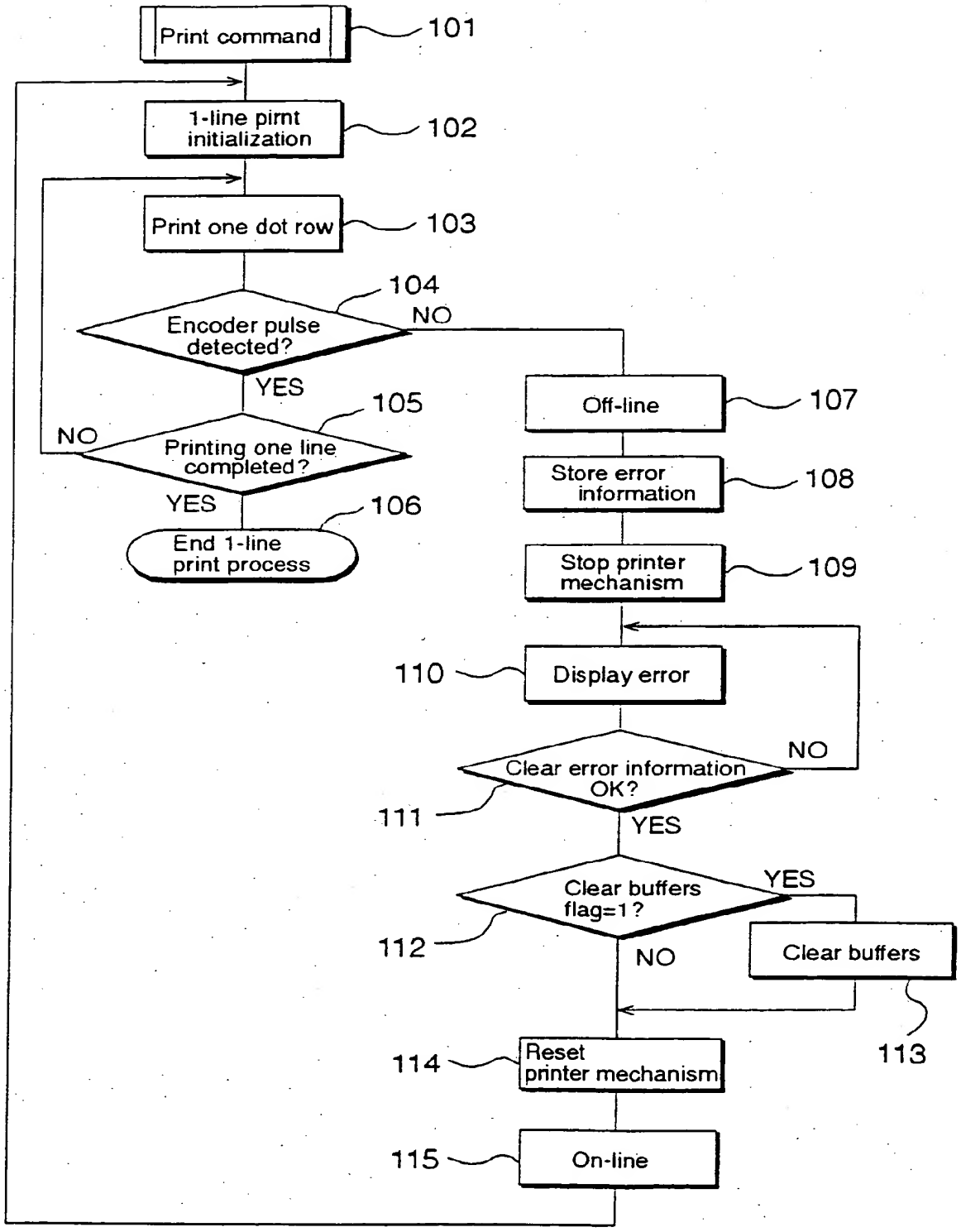
Print command
101
1-line pirnt initialization
102
Print one dot row
103
104
Encoder pulse detected?
NO
YES
105
NO
Printing one line completed?
YES
106
End 1-line print process
Off-line
107
Store error information
108
Stop printer mechanism
109
110
Display error
NO
Clear error information OK?
111
YES
YES
Clear buffers flag=1?
112
NO
Clear buffers
113
114
Reset printer mechanism
115
On-line

FIG. 10

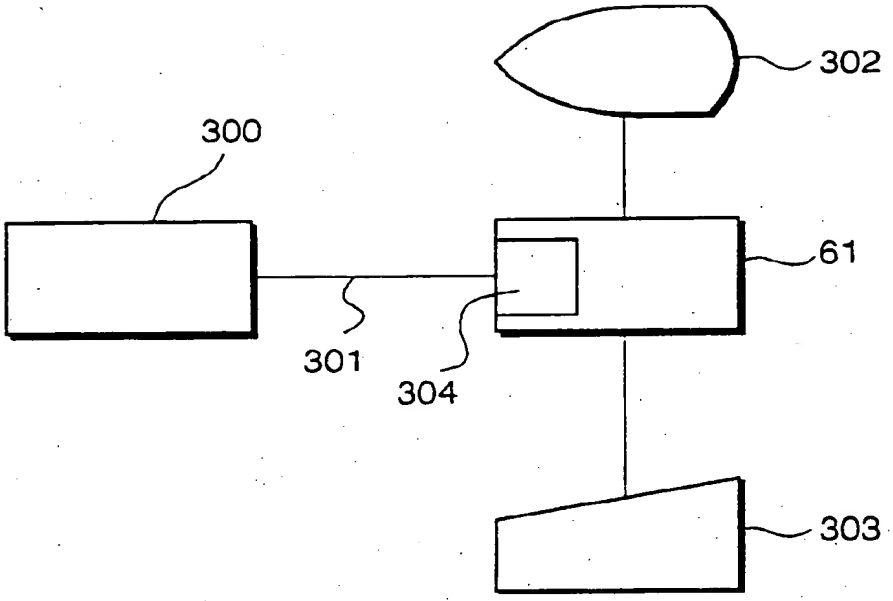

FIG. 11

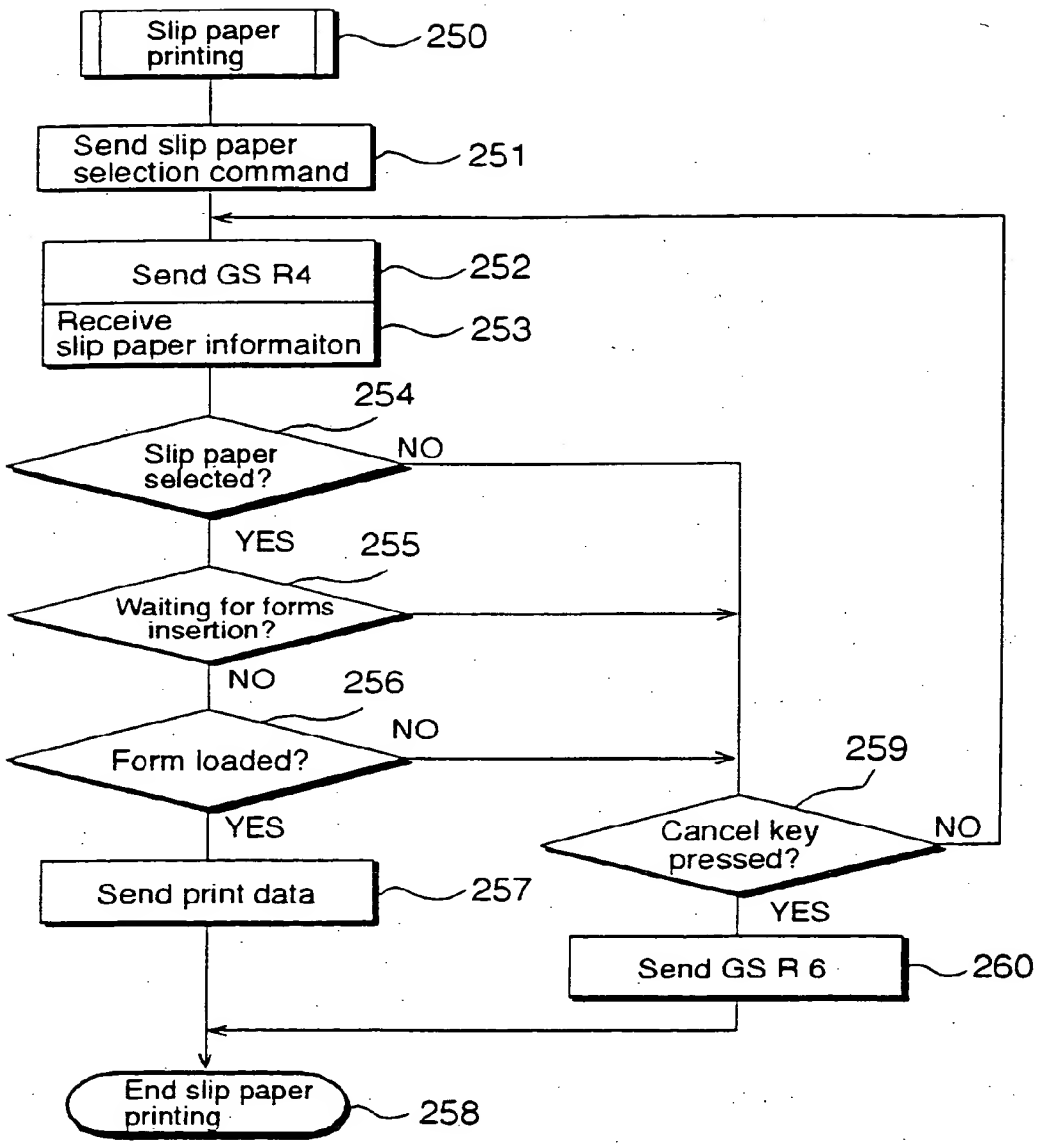
Slip paper printing
250
Send slip paper selection command
251
Send GS R4
252
Receive slip paper informaiton
253
254
Slip paper selected?
NO
YES
255
Waiting for forms insertion?
NO
256
Form loaded?
NO
YES
259
Cancel key pressed?
NO
YES
Send print data
257
Send GS R 6
260
End slip paper printing
258

FIG. 12

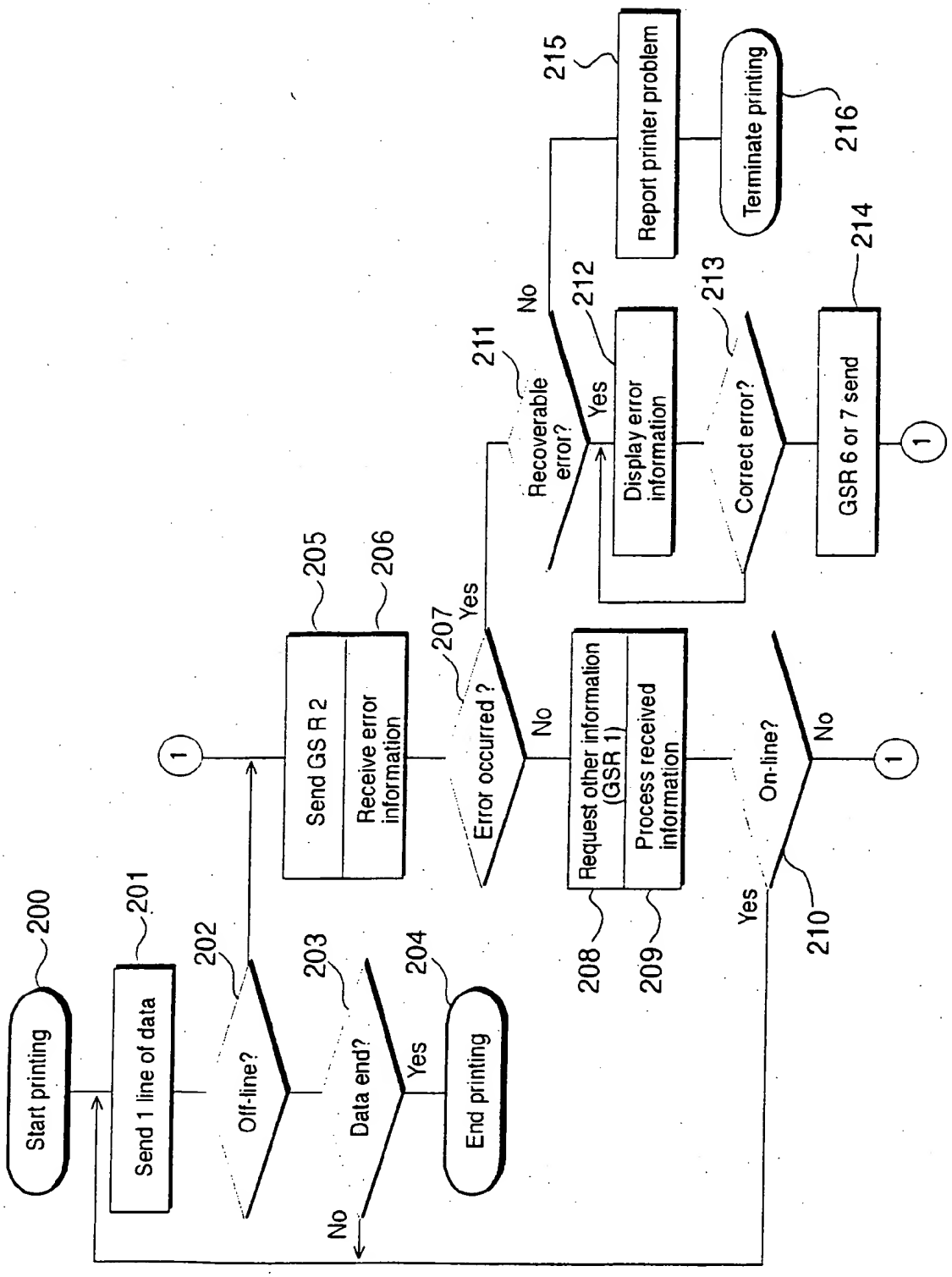
Start printing
200
Send 1 line of data
201
Off-line?
202
Data end?
203
Yes
End printing
204
No
Send GS R 2
Receive error information
205
206
Error occurred ?
207
Yes
No
Request other information (GSR 1)
Process received information
208
209
On-line?
210
Yes
No
Recoverable error?
211
No
Yes
Report printer problem
215
Terminate printing
216
Display error information
212
Correct error?
213
GSR 6 or 7 send
214
1
1
1

FIG. 13

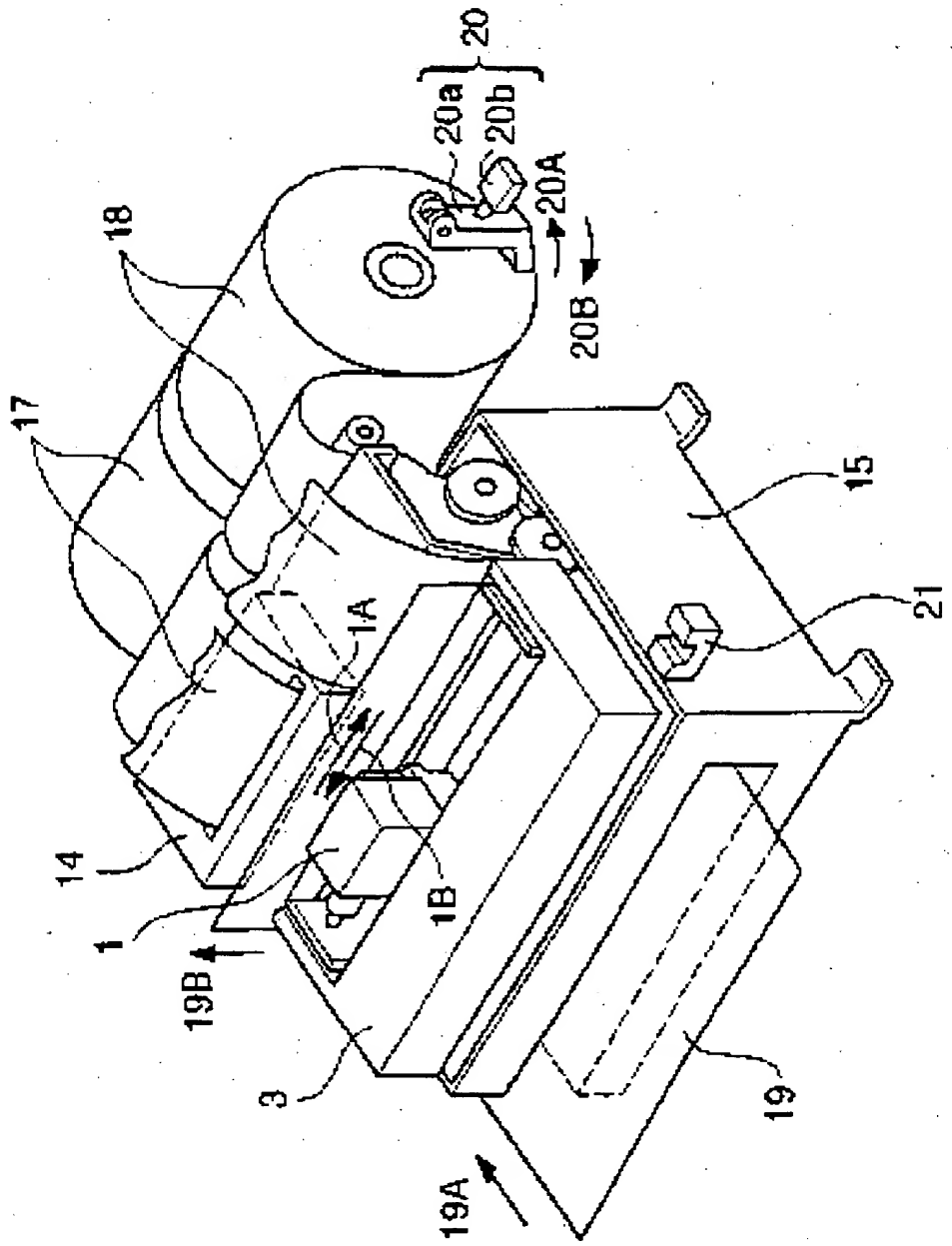

FIG. 1

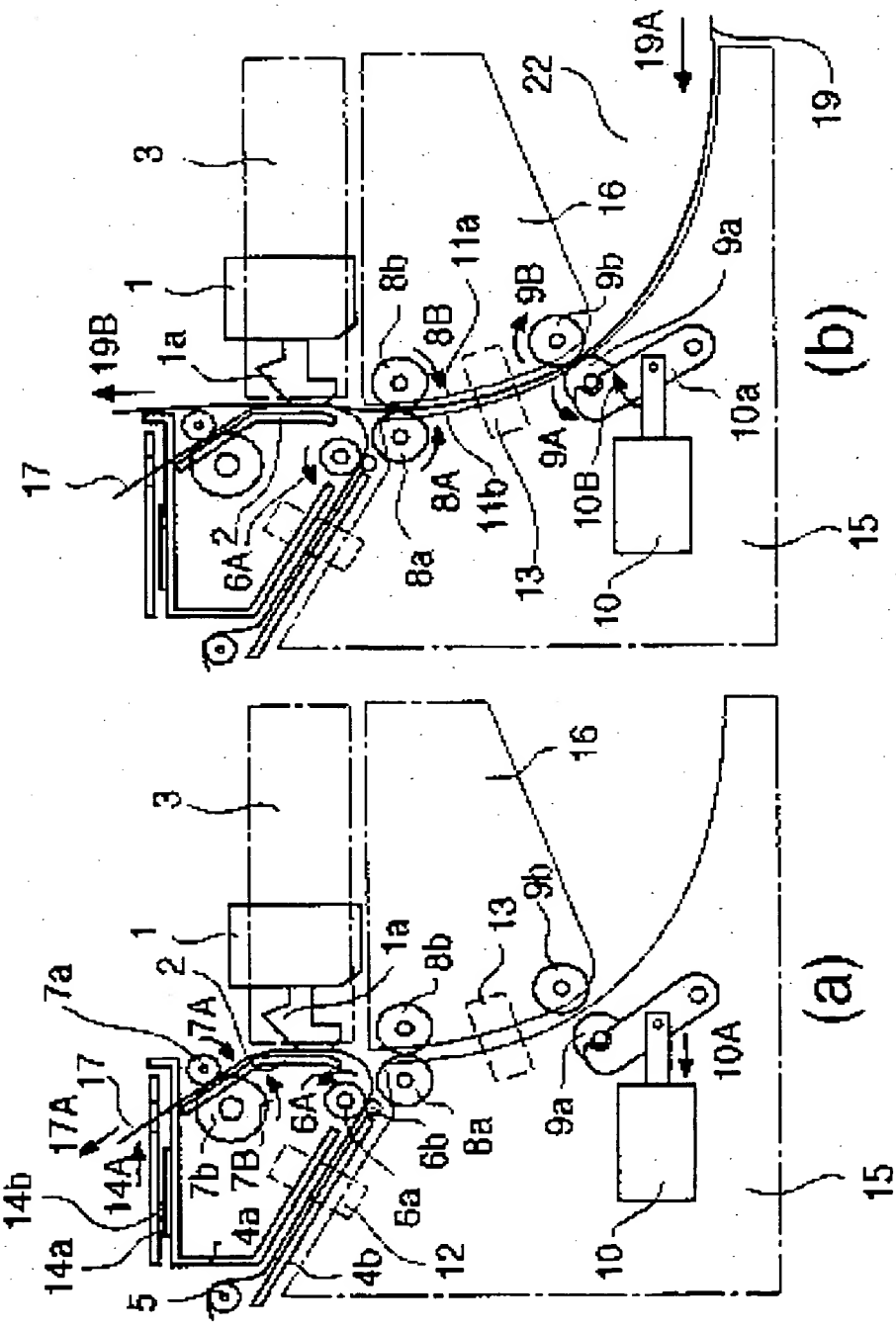
(a)
(b)
1
1a
2
3
4a
4b
5
6A
6a
6b
7a
7A
7b
7B
8a
8b
8A
8B
9a
9b
9A
9B
10
10A
10B
10a
11a
11b
12
13
14a
14b
14A
15
16
17
17A
19
19A
19B
22

FIG. 2

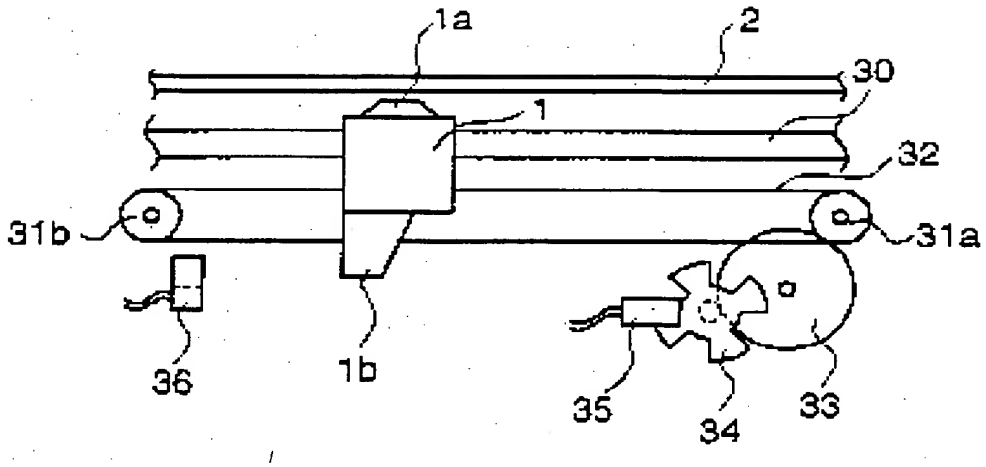

FIG.3

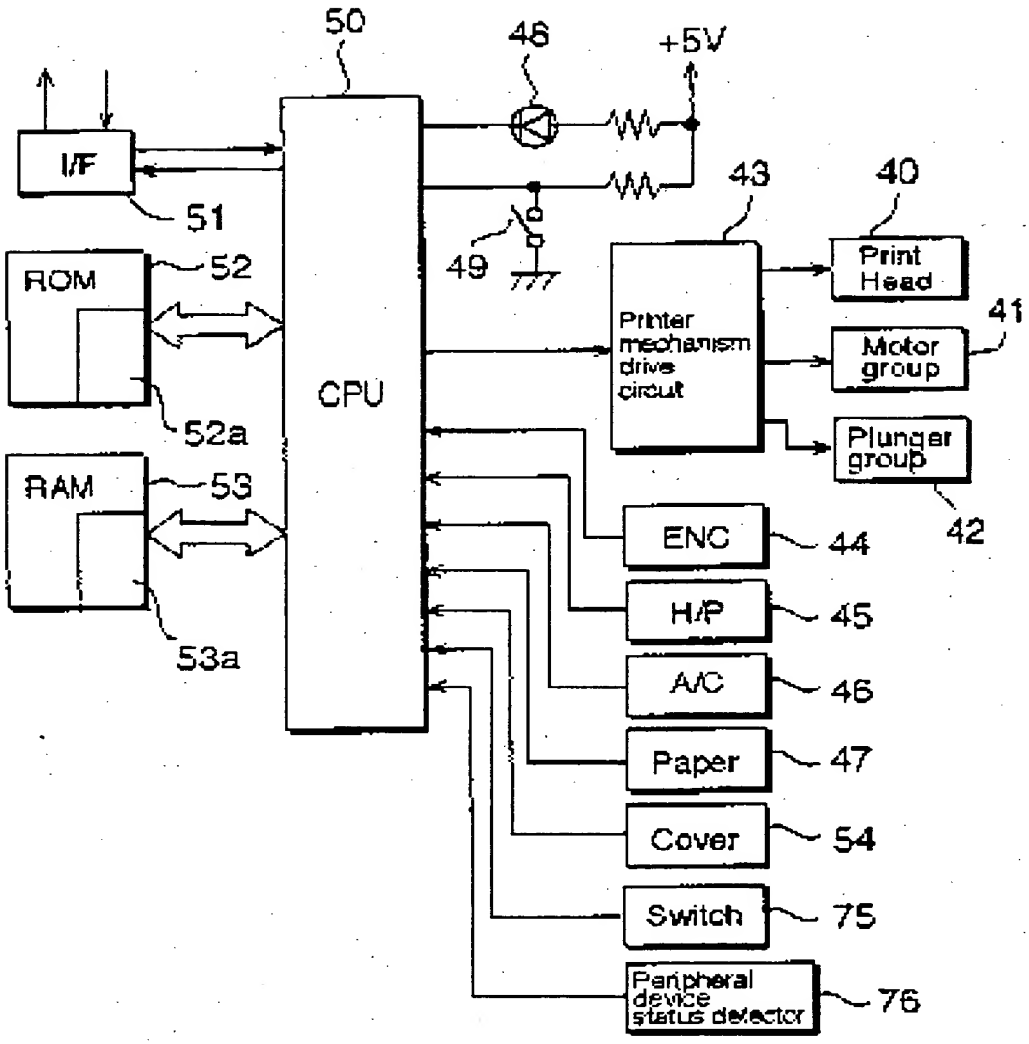
50
46
+5V
I/F
51
43
40
ROM
52
49
Print Head
Printer mechanism drive circuit
41
Motor group
CPU
52a
Plunger group
RAM
53
42
ENC
44
H/P
45
A/C
46
53a
Paper
47
Cover
54
Switch
75
Peripheral device status detector
76

FIG. 4

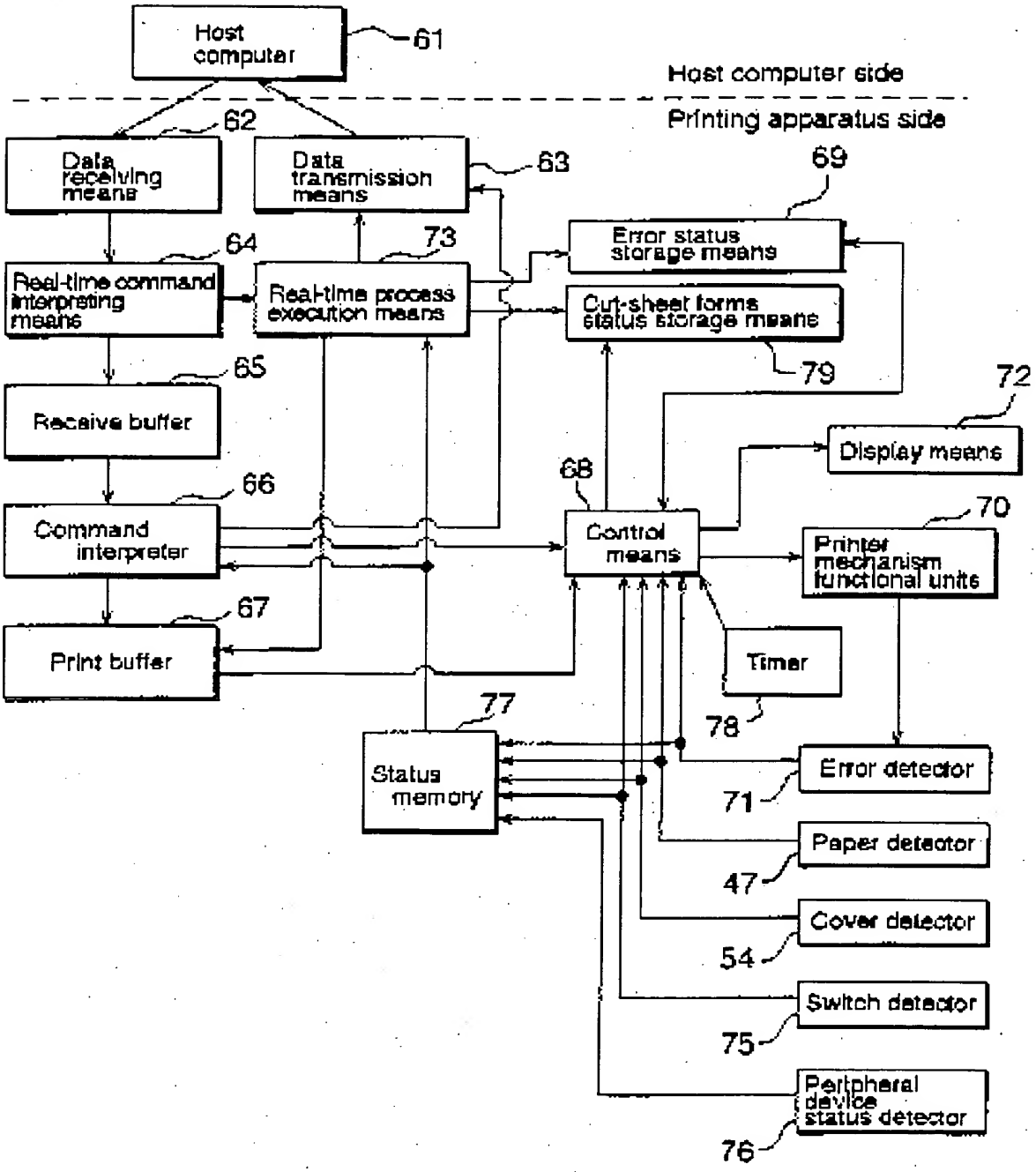
Host computer
61
Host computer side
Printing apparatus side
62
Data receiving means
Data transmission means
63
69
Error status storage means
64
Real-time command interpreting means
73
Real-time process execution means
Cut-sheet forms status storage means
79
65
Receive buffer
72
Display means
68
66
Command interpreter
Control means
70
Printer mechanism functional units
67
Print buffer
Timer
78
77
Status memory
Error detector
71
Paper detector
47
Cover detector
54
Switch detector
75
Peripheral device status detector
76

FIG. 5

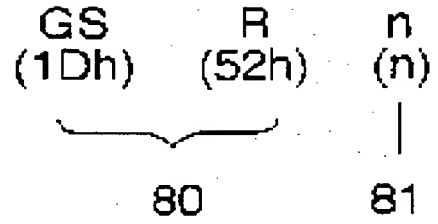

FIG. 6

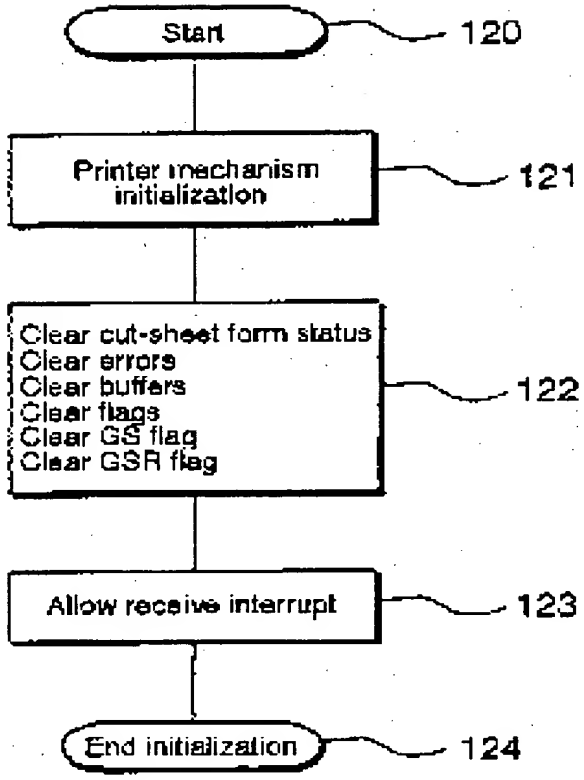
Start
120
Printer mechanism initialization
121
Clear cut-sheet form status
Clear errors
Clear buffers
Clear flags
Clear GS flag
Clear GSR flag
122
Allow receive interrupt
123
End initialization
124

FIG. 7

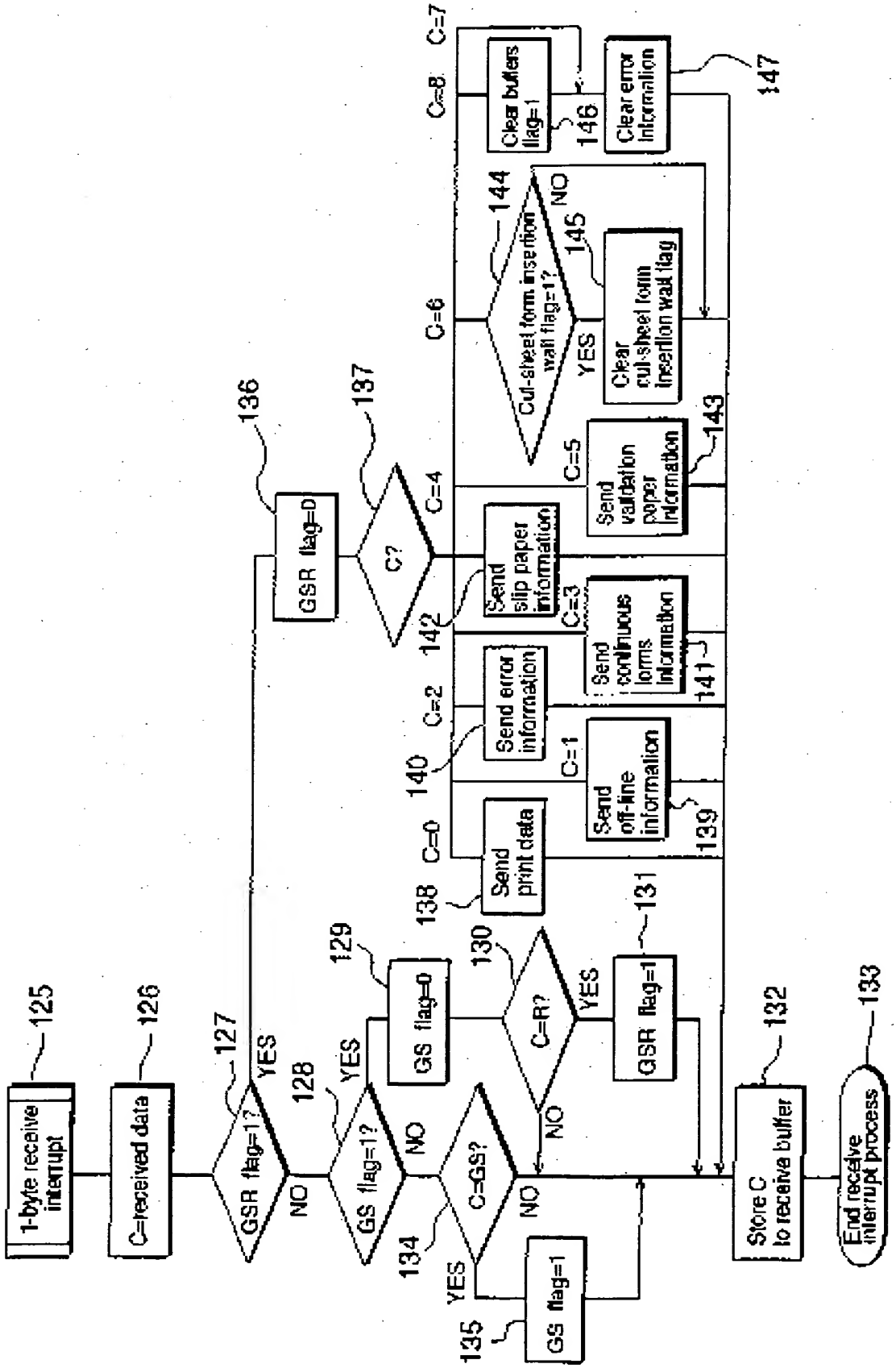
1-byte receive interrupt
125
C=received data
126
GSR flag=1?
127
YES
NO
GS flag=1?
128
YES
NO
GS flag=0
129
C=R?
130
YES
NO
GSR flag=1
131
Store C to receive buffer
132
End receive interrupt process
133
C=GS?
134
YES
NO
GS flag=1
135
GSR flag=0
136
C?
137
C=4
C=5
C=6
C=7
C=8
Send slip paper information
142
Send validation paper information
143
Cut-sheet form insertion wait flag=1?
144
NO
YES
145
Clear cut-sheet form insertion wait flag
Clear buffers flag=1
146
Clear error information
147
C=3
Send continuous forms information
141
C=2
Send error information
140
C=1
Send off-line information
139
C=0
Send print data
138

FIG. 8

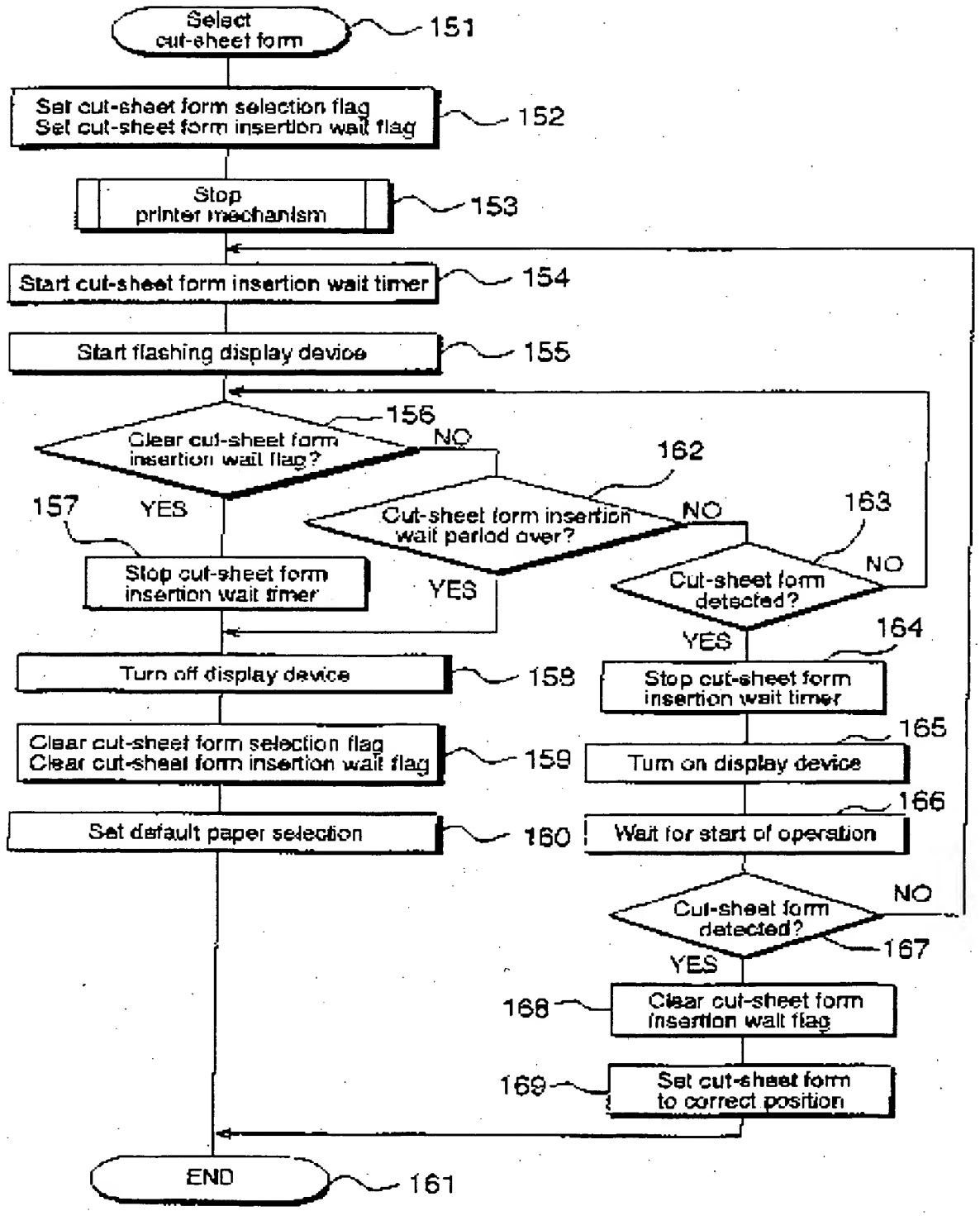
Select cut-sheet form
151
Set cut-sheet form selection flag
Set cut-sheet form insertion wait flag
152
Stop printer mechanism
153
Start cut-sheet form insertion wait timer
154
Start flashing display device
155
156
Clear cut-sheet form insertion wait flag?
NO
YES
157
Stop cut-sheet form insertion wait timer
162
Cut-sheet form insertion wait period over?
NO
YES
163
Cut-sheet form detected?
NO
YES
164
Stop cut-sheet form insertion wait timer
Turn off display device
158
Clear cut-sheet form selection flag
Clear cut-sheet form insertion wait flag
159
165
Turn on display device
Set default paper selection
160
166
Wait for start of operation
Cut-sheet form detected?
NO
YES
167
168
Clear cut-sheet form insertion wait flag
169
Set cut-sheet form to correct position
END
161

FIG. 9

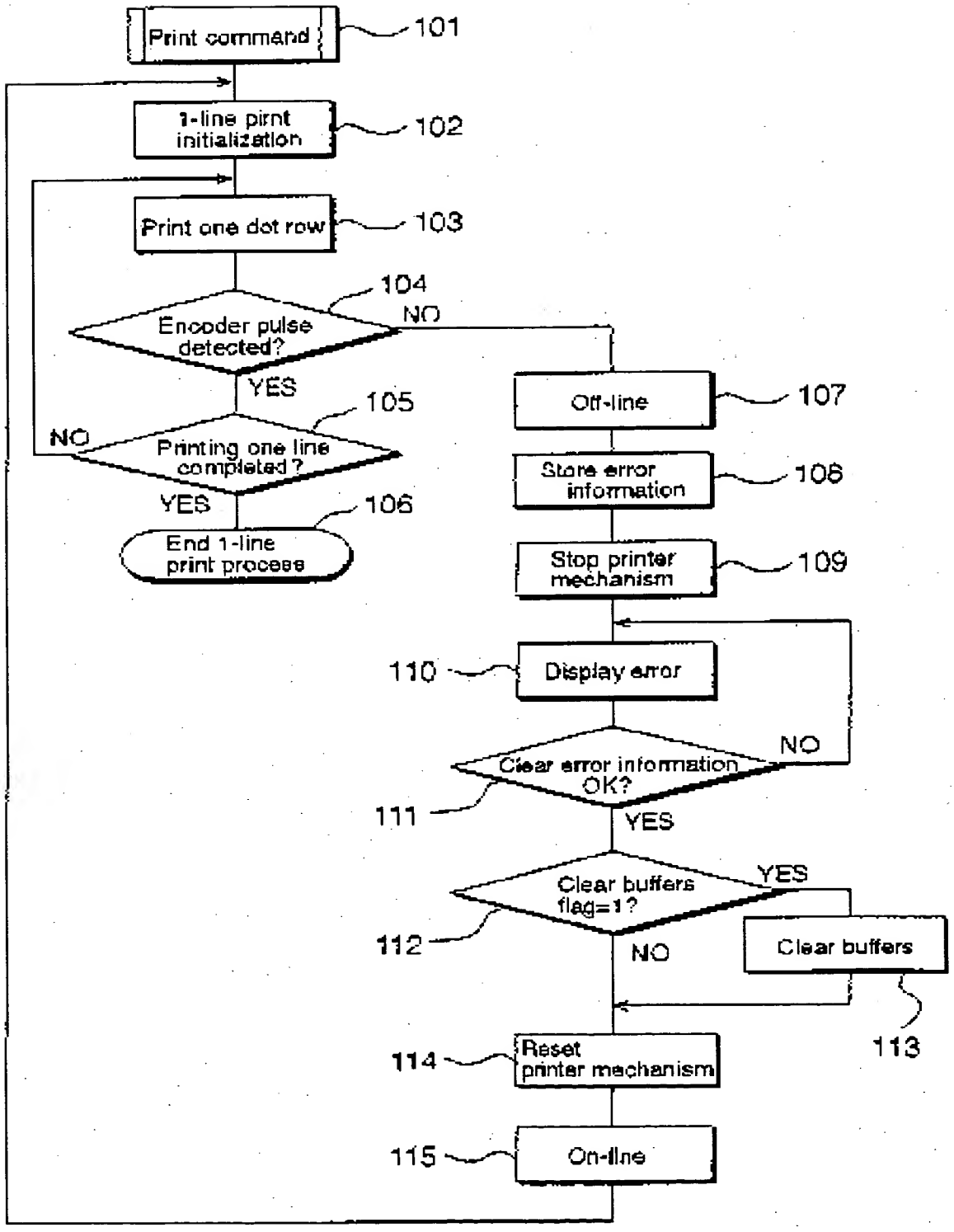

FIG. 10

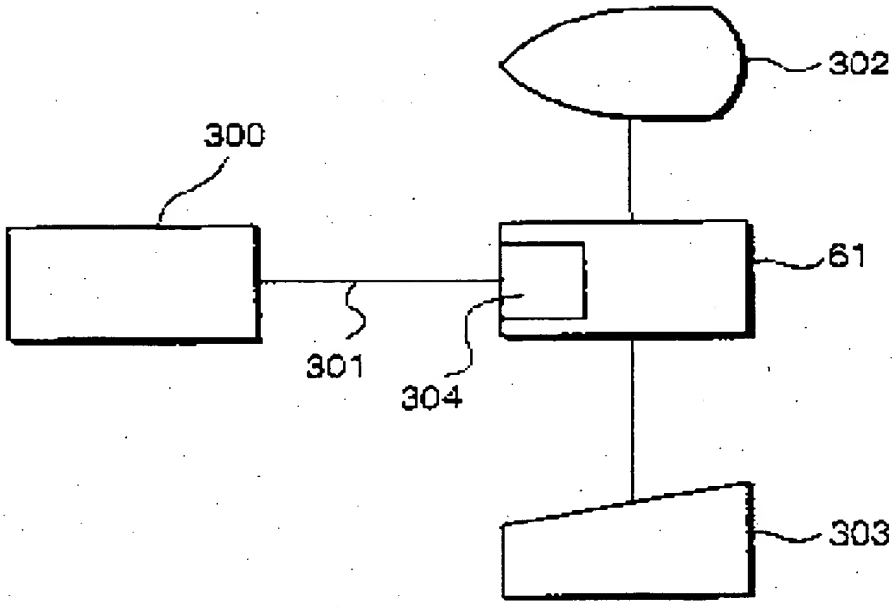

FIG. 11

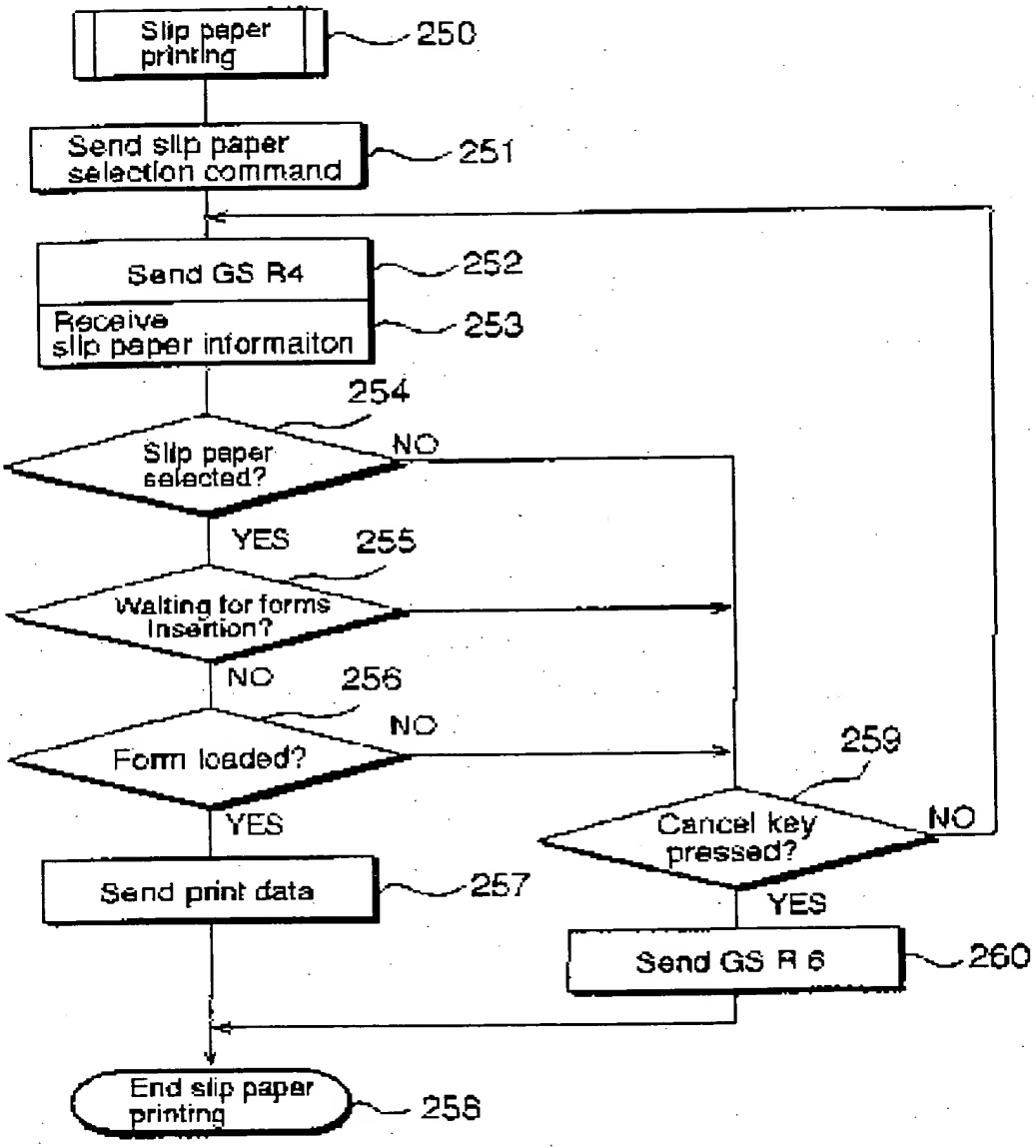

FIG. 12

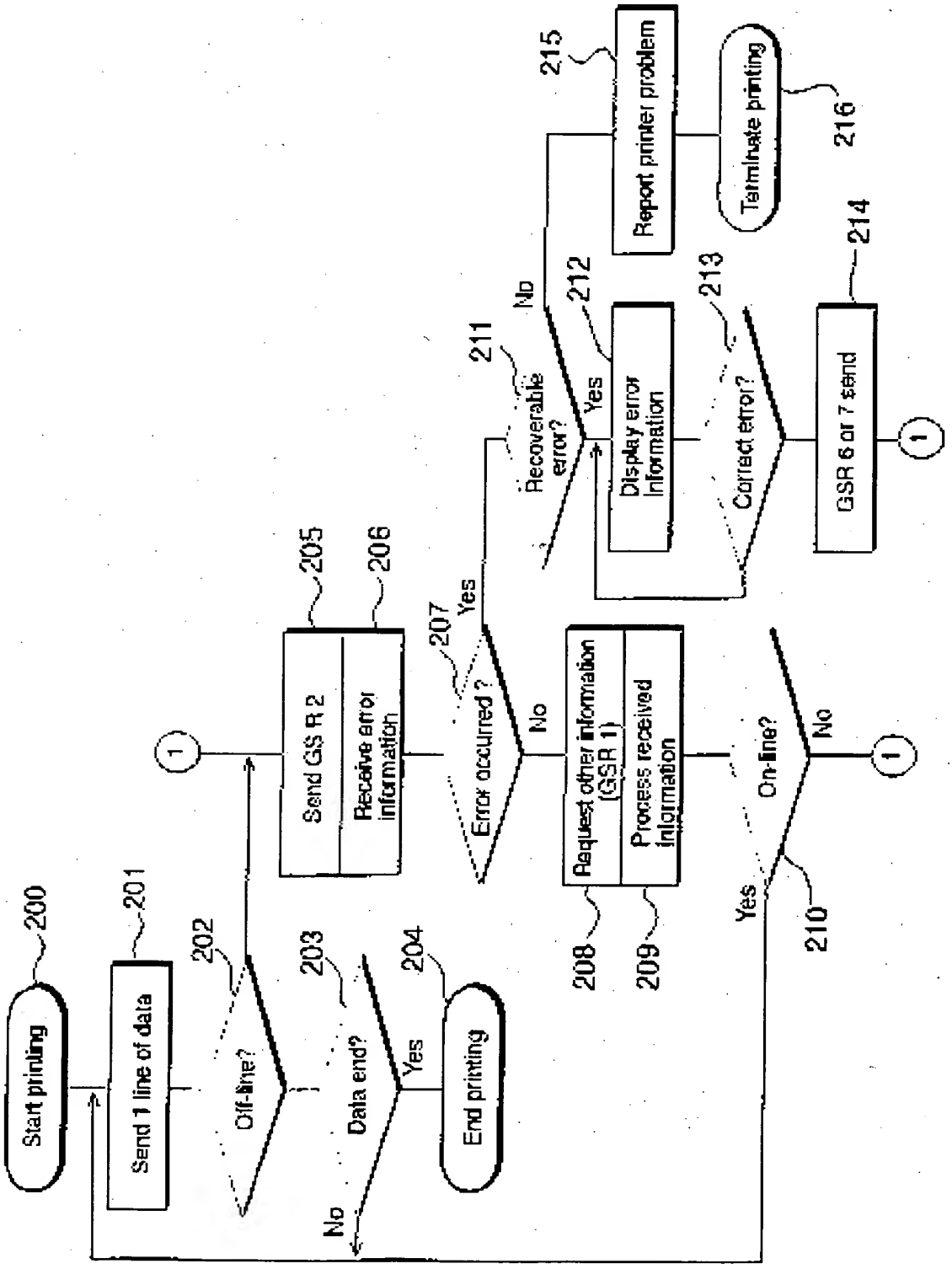
Start printing
200
Send 1 line of data
201
Off-line?
202
Data end?
203
End printing
204
Send GS R 2
205
Receive error information
206
Error occurred?
207
Request other information (GSR 1)
208
Process received information
209
On-line?
210
Recoverable error?
211
Display error information
212
Correct error?
213
GSR 6 or 7 send
214
Report printer problem
215
Terminate printing
216
Yes
No
1

FIG. 13

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 652 533 A3**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **94117601.8**

(51) Int. Cl.6: **G06K 15/00**

(22) Date of filing: **08.11.94**

(30) Priority: **08.11.93 JP 278637/93**
08.11.93 JP 278638/93
08.11.93 JP 278639/93

(43) Date of publication of application:
10.05.95 Bulletin 95/19

(84) Designated Contracting States:
CH DE FR GB IT LI NL SE

(88) Date of deferred publication of the search report:
02.11.95 Bulletin 95/44

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(54) Detection of the condition of a printer.

(57) A printing apparatus has, in addition to a normal command interpreter (66), a real-time command interpreter (64) for simultaneously analyzing control commands as data is received from a host device. This real-time command interpreter functions even when the printing apparatus is off-line, thereby enabling the status of the printing apparatus to be known even when the printing apparatus is not operating. Thus, the host device can be notified of the cause for non-operation thereby achieving a high throughput rate printing. The user can cancel a cut-sheet paper insertion wait-state at any time. Why an error occurred can be determined in an off-line state to enable recovery from the error.

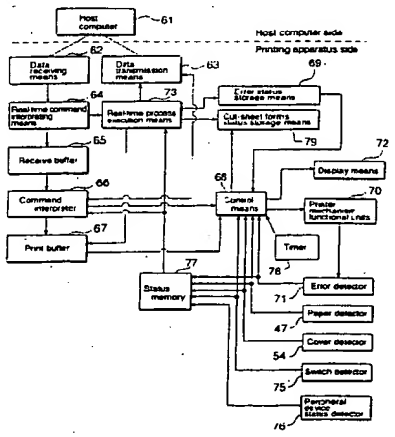

FIG. 5

EP 0 652 533 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 11 7601

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	US-A-5 124 809 (KOISHIKAWA) 23 June 1992 * column 14, line 60 - column 18, line 42 * ---	1,17	G06K15/00
A	EP-A-0 470 782 (THE PEERLESS GROUP) 12 February 1992 * abstract; claims * ---	1,17	
A	DE-A-38 11 661 (MINOLTA CAMERA K.K.) 27 October 1988 -----		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

G06K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	5 September 1995	Gélébart, Y

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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